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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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Geology and the Foundry.

It does not appear to be generally known that there is a very close association between the foundry and the twin studies of geology and mineralogy, and whilst we do not suggest that this subject should form part of the curriculum of the apprentice moulder, we do insist that every manager should be acquainted with its rudiments.

Basically, the analogy is very strong, for rocks admit of a rough classification into igneous, or those which have been formed by the action of fire, and aqueous, which relates to those deposited by the action of water. In the foundry the metals and their slags can be regarded as artificial igneous rocks, whilst some of the slag-making materials and refractories are actually derivatives of aqueous formations. There is still another variety of rock, called metamorphic; these are aqueous rocks, which, through volcanic or other action, have been burnt or changed. Here again there is a similar action in the foundry when the molten metal comes into contact with the sand mould. Whilst these and similar analogies do not entirely help the foundrymen to make better castings at a lower cost, the study of geology and mineralogy will often disclose new and helpful view-points. He no longer looks on sand as such, but as silica, containing more or less clay, which latter is regarded as silicate of alumina. Slags often resemble very closely the rocks, not only in appearance, but also in composition, and it is in their manipulation that the young metallurgist of the "tame chemist" variety not only forgets his geology, but often his simple chemistry and elementary arithmetic.

On one occasion we remember a young chemist vainly struggling with a basic slag, which was required to be quite thick, or, in other words, to contain 60 per cent. of lime. This he knew. Additionally, he was aware of the amount of lime that had been added to form the slag, and finally he was *au fait* with the chemistry of the process. He was carrying out the process fairly correctly, except that he was ignoring the influence of time. On being asked what he thought the lime content was in the slag he correctly estimated it to be 40 per cent., yet on his own showing he was making additions exactly equal to 2 per cent. By the time he would have made his ten additions to give the required 20 per cent., he would probably require another 10 per cent., as during this period some thinning actions were working against him. Now to such a man, unless he receives training under a superintendent who will make him apply his knowledge, his knowledge of geology and mineralogy will simply make him a nuisance in any manufacturing concern, except as a routine chemist.

Some of the refractory manufacturers are studying intensively mineralogy, and are members of a technical society specially formed to deal with their products. In this work, many steel metallurgists and a few associated with foundries take part. Whilst the steel manufacturer has to cope with higher temperatures, the foundryman has to deal with quantity so far as sand is concerned, and he is still striving for a freely venting, highly refractory sand suitable for all classes of work, which can be used over and over again. Obviously, any foundryman with a knowledge of metallurgy or geology can say definitely that no sand, as we know it, will ever bring this about.

Some of the benefits to foundrymen which have come directly to our knowledge go to show that many practical advantages can accrue. In one case in the Alps a newly-appointed French foundry manager discovered, through his geological training, a large deposit of suitable sand in the bed of the Rhone, which ran alongside the works, that satisfactorily replaced material previously brought from Belgium and Paris.

Kieselguhr (diatomous earth) was brought to the notice of another foundryman during his geological studies, and is of use for roughly annealing castings, since it is so light that practically non-moving air surrounds the object covered, and prolongs enormously its rate of cooling. The efficiency of furnaces can be considerably improved by placing kieselguhr between the metallic containing plates and the refractory bricks. Kaolin, or china-clay, is the purest of clays, and also the most refractory. These points are emphasised so strongly in geological lectures that when experimenting the foundryman-geologist could never regard it as other than one of his most useful refractories.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Derelict Plant.

To the Editor of The Foundry Trade Journal.

Sir,—I have read your remarks on derelict plant with interest, and may I offer you my experience as an expert of 15 years with all types, makes, and sizes of modern power moulding machines. I agree they do their work in a proper and efficient manner, the trouble is with the management almost in every case. They generally put in the machine first, and afterwards an expert. The best way to be successful is to find the expert, then put in the machine and progress would be made. As an example, in one place in particular, where I was called in, to look after the erection and starting up of a new moulding machine, may be given. When the machine arrived I warned the managing director it would not be safe to work it. The instructions I received were to go ahead. Anyhow the time came to start up this machine; I myself made two drags perfectly from a pattern. I refused to train anyone to work this machine; the maker's expert and patentee was called to start up the machine; the result was, the first time he turned on the air he blew up the jolting piston high in the air and smashed it up. This case adds weight to my contention, that it is necessary to find the expert, to discuss the work to be carried out, and then to go ahead with machines.

In the machine shops, precision tools are made, and no expense is too much in their manufacture. Why not the same for moulding-machine production?

To understand moulding-machine practice a foreman must train himself in the mechanical working; he must understand the working parts thoroughly, for instance, owing to the action of sand in the working operation, a small particle of sand in the jolting valve will often make it stick. If a foreman understands his machine he immediately knows what to do without the machine standing idle all day waiting for a fitter to take it to pieces.

I have read also the discussion (Lancashire Branch) wherein it was stated that in a 24-in. square grid or grate the core did not leave on a turn-over moulding machine. May I point out that the trouble there is in the design of the pattern plate, not the machine. To illustrate this, it is only necessary to consider what happens when a boy puts a leather sucker on a wet floor and tries to pull it off. It will scarcely give way, generally the string breaks. The same action occurs in moulding; facilities must be provided to overcome the suction.

The most important trouble, after pattern plate, is the correct design of moulding boxes, if mass production is to be maintained. No special sand-handling plant or conveyors need be used to get 250 boxes per nine-hour day with two men operating a Tabor short-draft squeezer.

Here are a few things I know are being made on moulding machines:—6 ft. driving locomotive flywheels, vacuum cylinders, pistons, gas- and oil-engine beds and cylinders, man-hole covers, tunnel plates, motor casings, pulleys, axles boxes, and others too numerous to mention.

I may add I am not in any way connected with any firm of moulding machines, being only one who has been through the mill.—Yours, etc.,

F. C. Barker.

9, Victoria Terrace,
Newark-on-Trent.
March 18, 1922.

The Foundry Exhibition: Visit by Employees.

To the Editor of The Foundry Trade Journal.

Sir,—The very interesting announcement you make in this week's issue as to a London foundry starting a fund to enable the employees to visit the Exhibition is one that should be copied all over the country. It has to be remembered that this is not only the first Foundry Exhibition in this country, but the first thoroughly organised Exhibition in Europe, and it will be the very best educational medium an employee can have because he will see concentrated in one large building all the very latest modern plant that is required for the proper production of castings. I hope that every foundry proprietor will consider that it is to his benefit to send all his staff to the Exhibition, and that every employee will make some sacrifice to enable him to visit it. I would add that all the railway companies will run excursions to Birmingham for the Exhibition.

The competitions in core-making, moulding and pattern-making will, we consider, be object-lessons to every employee.—Yours, etc.,

Thos. Vickers,
Hon. Secretary, Exhibition Technical Advisory Committee.

Central House,
New Street, Birmingham.

British Non-Ferrous Research Association.

Progress in non-ferrous metals research was discussed at the second annual meeting of the British Non-ferrous Metals Research Association, held at Birmingham on March 3. Mr. T. Bolton, who presided, comprehensively surveyed the activities and progress of the Association, which has now over 100 member firms. A number of investigations were being conducted by the Association in various laboratories. He referred particularly to the proposal of the Association to establish University Fellowships for post-graduate research.

Vice-Admiral Sir George Goodwin urged the Association to make its work more widely known, and stated that marine engineers and shipbuilders would be prepared to listen to proposals for membership if the Association's programme were put before them. The scientific metallurgist, the manufacturer, and the user should have their knowledge and experience combined for the benefit of themselves and the nation.

Sir Henry Fowler, chief mechanical engineer to the Midland Railway, trusted that the railway companies would soon be in a position to support such work. Users could help the Association as members by testing materials under service conditions.

Sir Gerard Muntz emphasised the fact that research should preferably be handed over to specialists. In the factory it was frequently neglected for other pressing work.

Sir Frank Heath, secretary of the Scientific and Industrial Research Department, gave several illustrations to show the value of co-operation between user and producer. He thought the provision of an intelligence service was one of the most valuable things an Association could do. He was also particularly interested in the projected establishment of research studentships, and offered the assistance of his department in working out a scheme. The growing appreciation of the value of research was indicated by the absence of any reference to his department in the proposals made by the Geddes Committee.

Deaths.

Mr. D. Halpin, M.I.Mech.E., died recently.

Mr. W. Barton, of W. H. Dorman & Company, Limited, died on March 2.

Major T. Prestige, a director of J. Stone & Company, Limited, marine engineers, died recently.

Mr. W. Borland, of William Borland & Company, ironfounders' merchants, Howard Street, Glasgow, died recently.

Mr. D. W. Kemp, of Robert Anderson & Company, metal merchants, Jane Street, Leith, died recently in his seventy-seventh year.

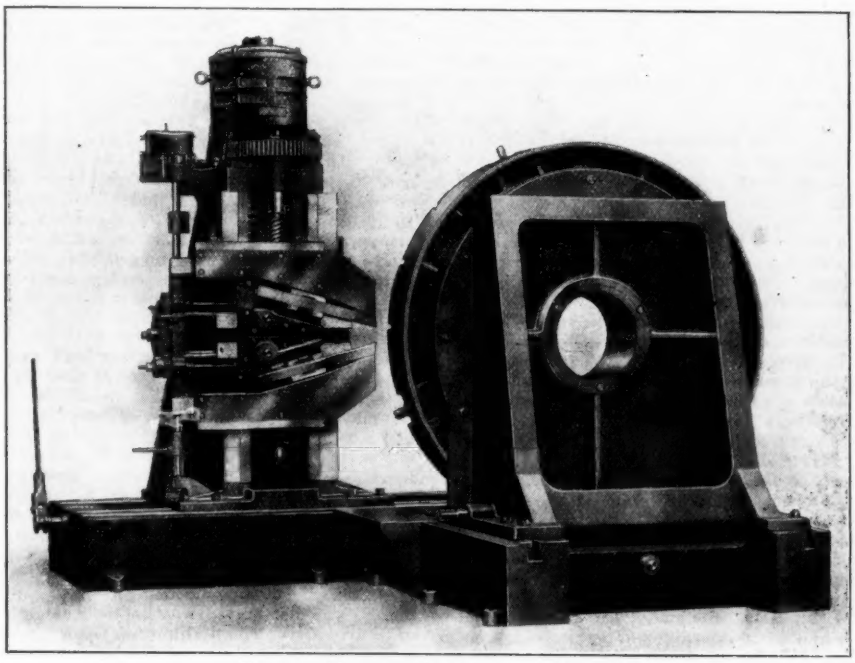
Mr. C. W. Tate, who has died at Whitley Bay, was head of the firm of Messrs. C. H. Tate and Son, naval architects and engineers, Side, Newcastle. The deceased, who was 74 years of age, was a native of Low Walker, his father being associated with the ironworks of Messrs. Losh, Wilson and Bell. He served his apprenticeship in the drawing office, and became chief draughtsman of Messrs. Charles Mitchell & Company, shipbuilders, Low Walker, and commenced business on his own account in 1882.

Mr. G. Richwood, who has been sales manager of the machinery department of Millars' Timber and Trading Company, Limited, has resigned his position with that firm, and will take over the management of the constructional machinery department of Gaston, Limited, London, W.3.

Patent Git Slotting Machine.

The machine illustrated has been designed by Messrs. Clifton & Baird, Limited, Johnstone, N.B., with a view to cheapening the cost of cutting off runners of steel castings. It may be recalled that the Company for many years made a speciality of powerful sawing machines for dealing with steel castings; realising, however, that the sawing principle was much too slow and expensive, apart from the fact that the sawing machine necessitated the use of a special and accurate machine for sharpening the saws properly, they embodied in the machine illustrated the modern and up-to-date method, taking full advantage of high-speed steel in the only practical way.

The main part of the machine is self-contained. The saddle carrying the tools is of special design, with large wearing surfaces, and double-gibbed to the guides on the column. It is worked up and down by a four-lead screw driven by a reversing motor carried on the top of the column. This column is carried on the bed, along which it can be traversed 5 ft. by an auxiliary motor and also by hand gear. Means are provided for securing the column to the bed during cutting operations.



GENERAL VIEW OF GIT SLOTTING MACHINE.

Cutting is done by two parting tools of high-speed steel, carried in tool-holders which are independent of each other, so that the tools may be adjusted to ensure that each takes its proper share of the work. The tools are held up to their work by deep steel plates (which are renewable), so that all overhanging strain is avoided. The tool-holders are pivoted to allow each tool to relieve itself automatically on its backward stroke. One of the tools has a V nose, and takes the lead, removing the centre of the cut, while the other is square, taking the sides of the cut.

The feed is automatic and in the horizontal direction, the holders being arranged to move across the saddle. The reversal is performed automatically by adjustable tappets, and the starting and stopping is controlled by push-buttons and also by a handle on the rocking shaft.

The machine is driven by a 12-h.p. motor. The maximum length of the cut is 30 in., and its maximum depth 10 in. With regard to working speed, it may be noted the machine will remove a riser 12-in. × 6-in. in section in twelve minutes.

The machine can be arranged with a revolving chuck and bracket on tee-slotted bed for dealing with wheels as per illustration, or it can be arranged with plain baseplate with tee slots and box tables for general work.

A New Chinese Works.

The Lung-Yen Mining Company formerly depended on Hanyang and other iron works for smelting the iron ore it produced. To send the ore from Peking (the Lung-Yen mines being in the vicinity of the Kalgan) to Hankow for smelting was far too costly a process, and this accounted for the high cost of the pig-iron produced. Realising this great inconvenience, the company decided to build a blast furnace and this is now under construction.

The site of the furnace is near the Western Hills, and has direct communication with Peking over the Peking-Mentoukow Railway. Work was begun in October, 1920, and will be finished by April, 1922, the construction covering a period of about 18 months.

When entirely completed, the furnace will be 147 ft. in height. It will have an average producing capacity of 250 tons of pig-iron every 24 hours, with a maximum capacity of 300 tons. The whole equipment includes, besides the furnace, five Wickes vertical tube boilers of 2,500 h.p., three electric generators of 2,500 kw., two turbine blowers, four stoves, and a number of pumps. The company will also construct a foundry capable of producing 20 tons of castings a day, a pattern shop, a blacksmith's shop, and a machine shop for repairs.

The equipment, costing $1,160,000 in U.S. currency, was ordered through the American Trading Company. Eight hundred labourers are now engaged in the construction work, under the supervision of three Chinese engineers, all of whom are returned students from America. The consulting engineers are members of the firm of Perin & Marshall, of New York City.

THE late Mr. A. Turner, of Cavendish Road, Edgbaston, Birmingham, ironfounder, left £6,716

AN EXPLOSION has occurred in the iron foundry at the works of George Kent, Limited, Biscot Road, Luton, as the result of which four men were injured, one having since died. As far as can be ascertained at present, it appears that the gas for the core-drying stove failed temporarily through an unknown cause, and the atmospheric burners went out. Presumably the gas must have been restored again, for when the deceased man went to re-light the stove some time afterwards there was a violent explosion, blowing the doors off and the sides out. Apart from the damage to the stove no material damage was caused to the other plant in the building.

XUM

The Institute of Metals Meeting.

Some Practical Points from the Discussion.

There were some practical points of interest to our readers during the course of the discussions on the papers at the recent meeting of the Institute of Metals in London.

Prof. H. C. H. CARPENTER, proposing a vote of thanks to the new President, Mr. Leonard Sumner, dealt with the remarks made in the address with regard to the training of young metallurgists, and hinted that he would seek the co-operation of manufacturers through the good offices of Mr. Sumner, with a view to making this training more effective for practical purposes so far as the Royal School of Mines is concerned. There is, he said, a great need for metallurgical students to have a knowledge of engineering, and for engineering students to have a knowledge of metallurgy. At present the facilities at the Royal School of Mines were not all that could be desired in achieving this result, and he hoped it would be possible for some financial assistance to be given by manufacturers which would assist him to improve the position in that respect.

Corrosion.

In the course of the discussion on the paper by Dr. Bengough on Corrosion, Mr. R. T. Rolfe, of Messrs. W. H. Allen Sons & Co., of Bedford, remarked on the fact that the Admiralty specification for condenser tubes, the British Engineering Standards Association specification, and the one proposed in the paper were all different, and what was the poor user to do? The reply was that the specification in the paper referred to special conditions, and that the other specifications could be used for ordinary conditions.

During the discussion on Dr. H. Moore and Mr. S. Beckinsale's paper on "Further Studies of Season Cracking," in which a low temperature annealing was recommended to prevent season cracking, Mr. Rolfe doubted whether the advantage gained would be worth the expense, seeing what a small proportion of cracked tubes there are in practice, viz., one in 114,000 in 1908, and one in 237,000 in 1913.

ENGINEER VICE ADMIRAL SIR GEORGE GOODWIN, the retiring President, said the Admiralty intended to carry out a test of both methods proposed by Dr. Moore and Dr. Bengough, and mentioned that there had been an epidemic of cracked tubes in the Channel Fleet recently and also in store. Certain experiments had been made with Dr. Moore's process and it seemed likely to go a long way towards meeting the trouble.

Nickel Silver.

Opening the discussion on a paper by Prof. F. C. Thompson and Mr. E. Whitehead on "Some Mechanical Properties of the Nickel Silvers."

MR. F. S. J. PILE said that whlist the paper was quite valuable from the scientific point of view, the authors had missed out what was perhaps the most important point in the whole thing from the commercial point of view. The great demand made upon manufacturers at the present time was for a metal which would stand the work required and at the same time give a surface which could be burnished without having to go through several operations. If the authors were continuing the work they might very well apply themselves to that side of the question. That involved considerations of what was the best annealing temperature and the best time of annealing. Only by careful consideration of these, among other points, could the required ductility and surface for polishing be obtained.

MR. W. B. CLARKE expressed the opinion that the non-ferrous metal industry would save literally thousands of pounds sterling a year if it would only adopt the bright annealing of its products. He had received many stamping from various manufacturers during the past twelve months, some of which, he would not say were a disgrace, but they ought never to have been turned out of any factory. The amount of pickling and polishing required to clean them would account for 10 or 15 per cent. of the metal used, and this indicated what an enormous amount of metal would be saved if the simple method of bright annealing was adopted. It was being largely used at the present time. Nickel silver was a difficult metal to anneal, and he would like to know whether, after being subjected to the temperature of 900 deg. C., any chemical analysis of the metal was taken. He rather fancied the authors would have found the percentage of zinc would have decreased considerably. Another point was with regard to the method of annealing. He had seen some of the annealing works in Birmingham and Sheffield, and they simply put the metal into a muffle furnace. Incidentally, the authors did not say whether it was closed or an open muffle furnace that they used. There was a great deal of difference according to which one was used. With an open furnace, especialy if gas or coke fired, they were liable to get sulphur fumes, because all the gas in the world was not free from sulphur, although it was supposed to be. As they used a closed furnace, on the other hand, great care should be taken when dealing with nickel and nickel-copper alloys, that there were no cracks in the lining. With the average muffle furnace it would generally be found to be cracked after two or three weeks, and unless the cracks were filled with some clay, remarkable results would be obtained. He had experienced this with some nickel alloy himself. It was found that the lining of the furnace had not been dovetailed, but was merely butted and cemented with clay. This clay had come out, and where the gas got through the cracks the metal was absolutely rotten. The method he had found most useful in getting a clay crucible to stand up to a high temperature was to paint the inside of a black lead crucible, which was the only one which would stand up, with clay; Osmose clay for preference. There were alundum and other clays which could also be used. His plan was to give the inside of the crucible two or three washes with clay, and the crucible then gave out as much heat as could be obtained with a plumbago crucible, and the amount of carbon that got into the metal was almost a minimum. As to the time of anealing, he had had experience of annealing tungsten, which was one of the most difficult metals to anneal, and the length of time of annealing was a most important matter, and the same applied to molybdenum. Therefore, did the times given in the paper represent the total time the metal was in the furnace or the time the metal was at the temperature mentioned? Then it was stated in the Paper that the metal was bedded in plaster of Paris, but it was not stated whether it was wet plaster of Paris. He would like to know if it were embedded in dry plaster of Paris, and also whether the authors considered that better than sand or magnesia, which could also be used for the purpose of preventing oxidation where a non-oxidising atmosphere was not available.

MR. WHITEHEAD recommended Mr. Clarke to the recipe for the manufacture of clay pots as used in the Sheffield steel works. This, he believed, would give him a furnace which would stand up to the temperatures he required.

Book Review.

LEHRBUCH DER EISENHUETTEKUNDE.—By BERNHARD OSANN. Vol. II.—Leipzig: Wilhelm Engelmann. (Price 175 marks, plus 100 per cent.)

This is the second volume of Professor Osann's treatise on the metallurgy of iron, and deals with the making and characteristics of malleable iron, or, as we should call it in this country, wrought iron, and of steel. The first volume, devoted to the production of pig-iron, was published shortly before or just after the outbreak of war, and is out of print. A second edition is in preparation. After a brief introduction the author deals briefly with the various processes of producing wrought iron. The third chapter is devoted to the Bessemer and other converter processes, the fourth to the open-hearth process, and the fifth to various refining processes. Chapter VI. considers the preparation of the metal for the forge and rolling mill, and in Chapter VII. the structure, properties, and ailments of wrought iron and steel are discussed, including cementation, hardening, etc. Foundry practice is reserved to a special volume, to be reviewed shortly. The book is intended for students and metallurgists in practice. The volume is well up to date.

Iron and Foundry Cupola Management.*

By J. J. McClelland, M.I.Mech.E.

A Practical Demonstration.

On the afternoon previous to the lecture entitled as above the members of the London Branch of the Institution of British Foundrymen were invited to a demonstration of cupola practice at the works with which Mr. McClelland is connected (Messrs. Jas. Evans (London) Ltd., Worton Road, Isleworth).

Mr. A. R. Bartlett, who was one of the four delegates appointed to investigate the matter, reports as follows:—

Details of Cupola Used.

Dia. of shell	4 ft. 6 ins.
Dia. of lining	2 ft. 6 ins.
Number of tuyères in use	Four.
Size of tuyères	4 ins.
Size of pipe between fan and wind belt	6 ins.
Height of charging door from sand bed	14 ft.
Height of tuyères from sand bed ...	2 ft.
Wind belt	2 ft. × 6 ins.
Weight of coke for bed charge ...	5 cwts.

Details of Bed Charge.

Depth of coke bed charge above tuyères in use	3 ft.
Distance between top of bed charge and charging door...	9 ft.

Other Conditions.

Blast pressure	16 ozs.
Tuyères in use	1 row
Start of blowing to appearance of metal	8 mins.
Time elapsed before the slag hole was tapped	30 mins.
Metal melted	50 cwts.
Time melting	40 mins.
Rate of output	3 tons p. h.
Time of firing before blast was put on	4 hours

Details of Charges (4½ Cwt.)

Charges 1 to 3.

Northampton No. 3	1 cwt.
Gartsherrie No. 3	½ cwt.
Stove and rainwater pipe scrap ...	3 cwts.

Charges No. 4 and Onwards.

All very light scrap.

Coke.

Amount of Durham coke used per charge	28 lbs.
Ratio of iron to coke	18 to 1

Flux.

Chalk per charge...	14 lbs.

It required eight charges as above to fill the cupola before starting to blow.

The metal was inclined to be dull and pasty for running either very light castings or for work to withstand very high tests, but as it was intended for brake blocks it was sufficiently good.

Introduction.

Many articles have been written on foundry practice, and much investigation has taken place from time to time with a view to improving upon past and present methods. Undoubtedly we owe much to scientific research for many of the modern advantages, which were difficulties to our predecessors, so much so that satisfactory solutions were never found.

With all the modern advantages, there are still many problems which baffle and mystify a great proportion of the large army engaged one way and another in the foundry trade, it being so vast and of so complex a nature.

It has also been considered by some, who ought to have known better, that the foundry was a sort of necessary evil, and as long as castings came along at all, it was useless trying improvements so far as the foundry was concerned, and all attention has been concentrated on other departments.

Within comparatively recent years, however, a change has taken place, an improvement which may perhaps be attributed to efforts made from time to time by public-spirited persons prompted by noble motives in an endeavour to help their fellow creatures to arrive at a better state of affairs and place their craft on a higher plane. The person who is fully competent in the foundry trade, is not only a highly intellectual person, but must be physically strong as well. This being so, it is obvious that the foundry must be made attractive to this class of people. Attempts to economise in cost of prdouction must be concentrated on any other part of the business in preference to the cost of labour.

Research has had a great deal to do with solving many of the problems in connection with the melting and mixing of metals. Much of the work, however, in this direction is so highly technical that it is out of the reach of a very large proportion of those engaged in foundry practice. The training necessary to fit them for it is so arduous that very few develop a desire to obtain those qualifications, and content themselves in muddling along with the old rule-of-thumb methods which have been picked up haphazard here and there, with the result that, with all the scientific efforts which have been made in the past, hardly one foundryman in a thousand knows how to manage satisfactorily a cupola.

Having had this fact very effectively impressed on his mind, also having had the opportunity of gaining extensive experience, and with a view to helping the trade to carry forward the movement for economy, the object of the author is to put forward an experience which he hopes will be helpful, and couched in such language that it will be understandable by the youngest apprentice and the novice. Also, to put on record a system of saving in cost of fuel which has met with extensive scepticism, almost sneering in character.

Although doubted by many, it is a fact that 18 cwt. of iron has been melted with 1 cwt. of coke, excluding the bed-charge, under the author's supervision, and having accomplished this result with varying sizes of cupolas, he has the utmost confidence in placing his experience within the reach of the foundry trade in general.

The Cupola.

If the most economical results are to be obtained it is obvious that the cupola, in which the melting takes place, must be a very important part of the plant, and, in fact, there are some foundrymen who appear to think it is all-important and that nothing else matters. On the other hand, there are some who think that any old boiler or shell stood upon end and having a charging hole, blast connections, and the rest fitted to it, is all that is necessary; but whilst it may be true that melting can be done under such circumstances, it is obvious that it cannot be possible to curtail the melting cost to a minimum. The contention therefore follows, that to get the best results, the whole melting unit must be in harmony.

The author, thinking it may be helpful, and from this point of view contends at the outset that the best results can only be obtained from cupolas designed especially to meet the situation. He will therefore deal with the design and capacity of each section of the melting plant separately, so that it will be more clearly comprehended by those who choose to be guided by his experience.

There is no objection to the plant being manufactured by the users themselves if preferred. Early experience with two home-made cupolas in the North of England gave very satisfactory results.

They consisted of cast-iron segment plates made with spigot-joints bolted together. Three plates made a complete circle or ring, about thirty inches deep, and the cupola was built up by one ring being placed on top of another, just as one would joint large gas pipes if they were placed on end. Each cupola was worked on alternate days, melting over one hundred tons per day, which meant an output of from ten to twelve tons per hour. There was no air belt, the blast pipes, two in number, blowing direct into the cupola, and the blast was supplied from a belt-driven "Roots" blower. The practical man will readily appreciate that with a melting plant made up as described

* A Paper read before the London Branch of the Institute of British Foundrymen on March 9.

the coke consumption would be very great indeed. In fact, it was one man's work feeding the coke alone, whilst two men charged the iron which was landed on to the charging stage from a bucket conveyor.

An American Experience.

One of the author's American experiences will perhaps give some idea of what can happen even nowadays, in spite of all the knowledge of the melting of iron which has been published broadcast by experts, to say nothing of the very extensive illuminated advertisements and catalogues which exist. A new cupola of modern design was installed. It was called rapid and economical, and according to dimensions should have melted from eight to ten tons of metal per hour, but because the maker of the cupola had only mentioned the merits and capacity of the cupola, no one else seemed to realise that the cupola could not melt iron satisfactorily without some auxiliary assistance. No consideration being given to the question of blast, the management thinking the blower they had installed for a smaller cupola would be good enough for the new and larger one, as it was understood to be an improved rapid cupola. It was therefore arranged that the blast should be supplied from the existing blower, with the result that with the first cast, they could only melt at the rate of two tons per hour. The next time the cupola was used, a larger pulley was put on to the countershaft to speed up the blower. The governor on the engine was also screwed down to get more speed, and additional coke was put on each charge, thinking greater heat through a larger fire would increase the melting capacity. Whilst there was some little improvement, it was not equal to the efforts made. Of course, this kind of procedure could not be continued for long without having some effect in other directions, and by the time the fourth attempt was made, one of the blades of the blower broke in the midst of a cast, with the result that the bottom had to be dropped, some metal poured into pigs on the floor, and a lot of work left uncast. A new blower had to be obtained quickly, the installation of which meant a new countershaft, new belting, etc. Obviously it would have been much cheaper to have put in a complete new plant at the outset.

When the new blower was installed and melting started again, there was another interesting development. By the time the cupola had been working three months it was found to require a new brick lining. This, of course, appeared strange, and naturally the cause was assigned to faulty bricks, so another make was tried, but with the same result. The cupola was only being used once or twice per week, and extensive inquiries were made, but no satisfactory explanation could be found. These experiences lasted for about two years, during which time two foremen were tried, and they in turn tried different furnacemen, with varying results of an unsatisfactory nature.

The author, when asked if he could give a solution, was astonished at what he had been told, but the experiences related led him to conclude that the trouble was not with the quality of the bricks. He eventually decided that the method of charging was the root of the evil.

The firm employed a furnaceman who took a keen interest in his work, and was anxious to do his best, but unfortunately he had never been properly instructed in the use of fluxing materials, and in consequence of having been advised that the flux helped to purify the iron, or, in other words, free it from dirt, he developed the idea that the more flux he used the better it would be for the iron. Oyster shell was the class of flux in use, and on each charge he was putting as much of this as coke. Consequently, whilst he was honestly trying to remove all dirt from the iron, he was also removing the brick lining as well. No amount of repairing with fire sand and clay would save the lining under such circumstances, and the effect of such treatment meant that during the two years there was a greater outlay of capital than would have been paid for a highly efficient complete installation.

War-Time Troubles.

Another experience which illustrates the small amount of interest taken by many foundrymen in this essential plant. In consequence of increased trade, a new cupola of modern design was installed to replace one of these home-made affairs, and owing to the company refusing to increase the cupola man's wages, he left their employ during the exchange of cupolas. When the new one was ready another man had to be engaged, and owing to the scarcity another cupola man could not be found in that area, so an ordinary labourer was taken on who had had some experience in stoking a portable boiler. The foundry foreman not being acquainted with cupola practice, the new man was left quite on his own, to do as he liked, and, of course, the very first cast resulted in a very serious display. The iron scaffolded, very little work was cast at all, and the staff had to work nearly all night to get the material out of the cupola.

Next day the makers received a telephone message to say the cupola had failed, and asked for a man to come at once to see what could be done. The author was asked to go and see them, and when he arrived there he found very much of the brickwork badly damaged, but they had managed to get all the material out. On inquiring what procedure they had followed, it was explained that the new cupola man had made up the bottom portion with the sand, etc., as best he could, and apparently had not gone far wrong with that part of the work, but when it came to charging the material on the cupola, he filled right up to the charging door with coke, and then put on all the iron without any further coke.

These experiences are by no means very exceptional. There are hundreds of foundries in existence using melting plants which are literally eating up money every time they are used. It is therefore advisable for all who contemplate putting down new melting plant to consult an up-to-date authority before risking what may mean a continual excessive expenditure, whilst the very best they could hope for would be a very small amount on the original outlay. In other words, do not be misled into installing the cheapest article if it is likely to cost more to work it when once it has been installed. Follow the same practice in the foundry as in a first-rate machine shop. Study economy in working, rather than buy the cheapest article.

Lay Out of Plant.

The position of the cupola in the foundry is also a very important question. More so if the metal is going to be melted rapidly, which must be the case if it is to be effected economically. It has been very wisely said that it is much easier to wheel pig-iron to a cupola on a barrow than it is to carry molten metal away from it. If convenient, the melting plant should be located as centrally as possible, but not necessarily in the middle of the foundry if the building is rectangular in shape. The most popular position would be as near the middle as possible, outside the longitudinal part of the building, with the tapping spout projecting through the wall into the foundry, thus avoiding using valuable space inside the foundry, which can be put to a far better use as moulding space, for it is not only the actual space on which the cupola stands, but there is always a certain amount of room required at casting time, and accumulations of shanks, clay pots, hand ladles, etc., which can just as well be stored in an open yard.

Obviously it is unnecessary to give a repetition of details for the various sizes of cupolas from the very small ones up to the largest sizes, so what may be called the most popular size will be dealt with. This can be used as a basis for any other size *pro rata:* the particulars given here should be sufficient for all sizes and capacities.

The type of cupola here preferred is what is known as a "drop-bottom air-belted," but a solid bottom would not interfere with the melting results, all other points being equal. The size is based on a 3 ft. 6 in. dia. shell. The brick lining should be 6 in. thick, and may be made of two thicknesses, each 3 in. The advantage thus gained is, that when the brick lining requires renewing, it will not be necessary to renew the whole, but only to remove the destroyed front bricks, replacing them with new, leaving the back ones undisturbed. An illustration of this principle is shown of the author's design of cupola in Fig. 1. With a lining as described, there would be an internal diameter of 2 ft. 6 in.

Receivers.

A recent design of cupola has a receiver for the molten metal instead of holding it in the well of the cupola. Theoretically, the idea of a receiver seems a sound suggstion, but the author is not prepared to recommend it, not having been im-

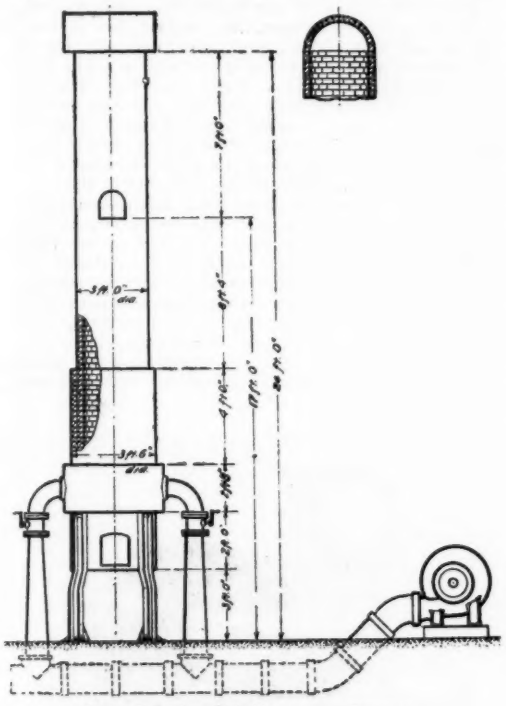


FIG. 1.—THE MCCLELLAND CUPOLA.

pressed by their utility from personal experience, and the opinion formed has been confirmed many times by others who have tried them. No saving in fuel was found, and instead of saving labour, additional work is made. The only virtue is that a better mixing of the classes of material is obtained. This same advantage can also be obtained by using a spout ladle. Therefore, the ordinary shell with an air-belt is recommended.

Whilst the shell is to be 3 ft. 6 in. in dia., with a 6 in. brick lining, the base of shell to be 3 ft. from the ground, and the distance from the base

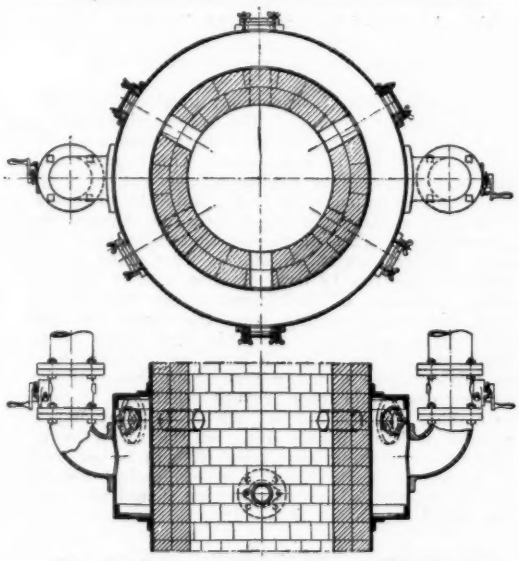


FIG. 2.—SECTIONS THROUGH THE HEARTH OF THE CUPOLA SHOWN IN FIG. 1.

to the underside of the air belt to be 2 ft., the air belt should be 1 ft. 3 in. deep and 4 ft. 2 in. in dia. For this size of cupola 6 tuyeres are recommended, not less than 4 in. in dia. each, and placed in a staggered position. The centres of the first row should be 2 ft. 4 in. from the base and centres of second row 3 ft. from the base. This will make the distance between centres of tuyeres 8 in. The air belt should have 2 inlets or connections for blast pipes, one at each side. The internal diameter should be 5 in. in each case, and should preferably be conical in shape to prevent air eddies and frictional losses as much as possible. Where circumstances will permit, a single air inlet, as shown in Fig. 3, gives as good results. In some cases they have appeared to serve even better.

The Position of Tuyeres.

Experience has also shown that it is advisable to avoid having tuyeres directly opposite each other, the resulting effect being that two currents of air beating against each other must create a neutral zone in the centre of the fire, where it is most desirable that the melting should take place, and this causes the air currents to creep up the brickwork and do the melting where it will have the most damaging effect on the lining, hence the conclusion that all multiples of tuyeres should be so arranged that there cannot be two directly opposite each other. To confirm this, it is only necessary to refer to the effect obtained from the centre tuyere cupola which was tried in the United States, where it was demonstrated by putting one tuyere up through the base and getting all the blast on the centre of the fire, the wear and tear on the lining was reduced to a minimum, and if it were not for the other difficulties attached to the centre tuyeres, such as keeping free from choking and the trouble of keeping it metal-tight, the writer would be favourably inclined to suggest its use, but the difficulties mentioned are somewhat fatal, and as the results obtained by other means are trustworthy, it is not necessary to take any risks.

The next measurement is from top of air belt to the under side of charging door, and this should be about 10 ft. 4 in. From the bottom of charging door to top of the cupola should be 7 ft., which makes a total height from ground level to top of cupola of 24 ft. for a shell of 3 ft. 6 in. dia.

Spark Arrestors.

Although a spark arrestor has no effect upon the melting capacity, they are essential adjuncts in congested areas, and in these days a cupola cannot be considered complete without one. There are numerous types and designs in use by various manufacturers, but a very serious drawback to many of them is the shortness of their existence. A design is therefore introduced here which has been tried many times and always successfully. It is claimed that this design can be firebrick lined,

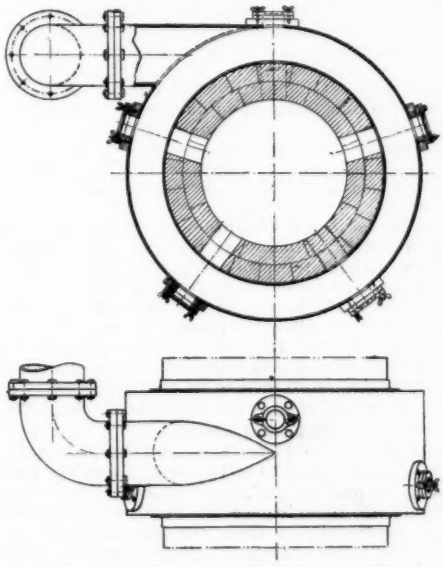


FIG. 3.—CUPOLA ARRANGED FOR A SINGLE AIR INLET.

which is impossible with many others, hence the reason of their short life. If they are to perish so soon from contact with fumes and gases, it is almost useless installing them. There are one or two other types in existence fireproof lined, but they are either too expensive or take up too much

space, but the one shown in Fig. 1 is neither expensive nor cumbersome, and certainly is very efficient.

Lining Details.

The brick lining of a cupola is a very important part of the melting unit, and certainly requires to be systematically fixed. As is well known in the steel trade, the ordinary bricklayer is not always the best man for doing this kind of work. The bricklayer is accustomed to putting a fair layer of mortar on each course of bricks for bedding, which is just the opposite to what is required when brick-lining a cupola. The best person for the job as a rule is a regular cupola man. One who has had experience in working a cupola and knows the results if a lining has not been properly built. In the first place, the very best firebricks should be obtained, as they always are the cheapest in the end.

They should also be the correct size and shape to fit the cupola shell, and as there are plenty of brickmakers who specialise in this class of goods, there is no difficulty experienced in getting exactly what is needed. The best fine fireclay should be used for building the bricks in, and it should be allowed to soak in tubs overnight before using. The fireclay should be diluted with water until it is almost as thin as heavy oil, so that when the bricks are being built up they can be rubbed so closely together that there is the minimum amount of jointing or bedding material between them. Thus, when the work is completed, an almost solid lining is obtained.

As mentioned, a double lining is preferable, and for the size of cupola under consideration, a 6 in. lining made up of two 3 in. thicknesses is a very convenient arrangement. If the man in charge of the cupola is one who takes an interest in looking after his plant, he will keep the lining in the melting zone well repaired with any suitable materials which may be available, and by so doing he will prolong the life of the brickwork for an almost indefinite period.

Charging Stage.

It is a fact that many foundry proprietors think almost anything will do for a loading stage, and it can often be noticed in large foundries where fairly large quantities of iron are melted, the work has to be accomplished from a platform with insufficient space to allow the charging-hand to move about properly. There is usually little or no room for stocking supplies. It is then a matter of little surprise if there are irregular mixing of materials. A fair-sized charging stage is quite essential, for very often the foundry has limited yard room, and if a stage will accommodate 20 tons or more of material it saves a great deal in the cost of handling, and in cases where casting is only done once or twice a week it permits a sufficient quantity being stocked on the stage, so that a minimum amount of labour is required at casting time. Where this cannot be done, it often means one or two hands have to be kept for casting time, who would otherwise not be needed. These are matters of the greatest importance in these days.

There is also the advantage of being able to put a quantity of material in stock in a handy situation without the prospect of the expense of a second handling when it is required for use.

There should also be sufficient room on the charging stage to allow the charges to be systematically weighed, for it matters not how clever or experienced a cupola-man may be in guessing weight, he cannot pretend to be accurate, especially if the materials vary much from heavy to light.

Mechanical Charging.

Every stage should also be provided with a suitable hoist, and in making this suggestion the fact it not being lost sight of, that there are mechanical arrangements in existence for doing the charging of the cupola direct from the ground, but circumstances have a decided influence on the question of taking materials to the charging door of the cupola, and it will be admitted by most practical people that mechanical charging as understood at present can only be applied to daily melting in large foundries, and even then, the cost of upkeep, owing to heavy wear and tear on both the elevator and cupola is a very serious off-set against any advantage gained. There is also the cost of having a separate elevator for each cupola installed. At present there is certainly room for improvement on elevator feeders from the ground.

This class of raising mechanism is not suitable for the type of cupola dealt with here as an average size, and which, in slack seasons, may only be used two or three times weekly, and perhaps less.

Now that electricity has become universally used, and being so convenient, the electric lift is very useful and economical, and a convenient size is one having a cage 5 ft. × 4 ft., with a ½-ton lifting capacity. This is a handy size for wheeling an ordinary wheelbarrow into the cage and taking it up on to the charging stage without further handling of the material. Where lifts of this class have been installed they have been known to enable the proprietors to dispense with the services of two men, when melting has taken place only three times per week. Where the cupola has been in use every day as many as three or four men's wages have been saved, in addition to making the work lighter for those who remained.

As every foundry has its own peculiarities it is always as well to get the opinion of experts, who would advise what they consider best to meet the local conditions, and there should not be too much attention paid to first costs in connection with these very essential items.

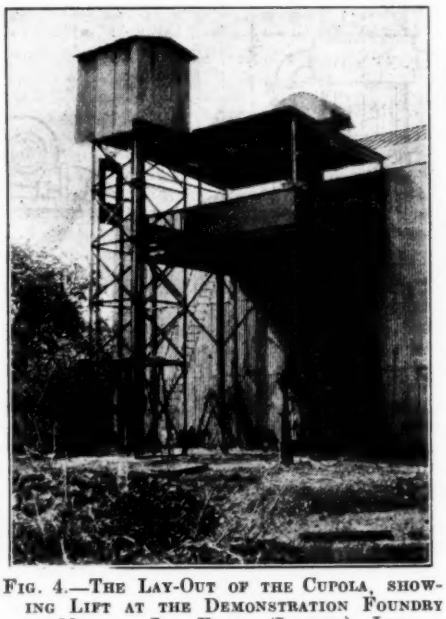


Fig. 4.—The Lay-Out of the Cupola, showing Lift at the Demonstration Foundry of Messrs. Jas. Evans (London), Ltd.

Fig. 4 illustrates a somewhat ideal combination for economical working. The stage, which has a capacity for holding 20 tons distributed load, is 16 ft. × 12 ft. in floor area. The cupola shell is 3 ft. 6 in., and the lift has a cage 5 ft. × 4 ft. with a lifting capacity of half a ton. An ordinary wheelbarrow can be wheeled into the cage at the ground level, taken up to the stage floor level, and wheeled direct on to the stage. This plant is one which is melting 18 cwt. of iron with 1 cwt. of coke, exclusive of bedcharge, every time it is used, the metal coming from the spout hot and fluid. The melting is so rapid that there is as much casting done in one hour, as is often done in two or three hours in many foundries. If the proprietors would only realise what this means in a year, it would not be long before many of the present melting plants were on the scrap heap, and before leaving this point it will be as well to emphasise that if the most economical results are to be obtained, every provision should be made for rapid melting and handling.

Fans or Blower.

No doubt every experienced person will agree that there has been considerable improvement in the design of fans during recent years, and now that the combined fan and motor is brought to such perfection there is still a good deal of controversy as to the advantages which may exist one way or another between the up-to-date fan and Roots blower. It is the intention of the author to say what he honestly thinks best.

Therefore, where it is convenient to install a combined direct-coupled fan with electric motor, together with a controller, the fan being constructed with vanes arranged somewhat on the turbine principle, the result is the most suitable blast-producer for iron-melting of the present day.

It should be noted that a direct-coupled electrically-driven fan is here preferred, but if electric power is not available and the blast-producing machine has to be operated by belt drive, then a Roots blower is preferred for the reason that fans as a rule must be run at a high velocity, necessitating a small pulley being attached to the fan, and where a speed of 3,000 revolutions per min. or upwards is required, it is practically impossible to give a guarantee that such a speed against pressure can be maintained with a belt-drive.

There are also other instances where it may be preferable to use a blower, and one is able, when it is necessary, to send the blast through a long length of piping. It can be safely said that air-pressure loses more through friction in passing through a long length of piping than any other means of power. It is also essential where, for some reason or other, the supply of piping may be smaller than it should be, that a blower should be given preference. It will be noticed here that it

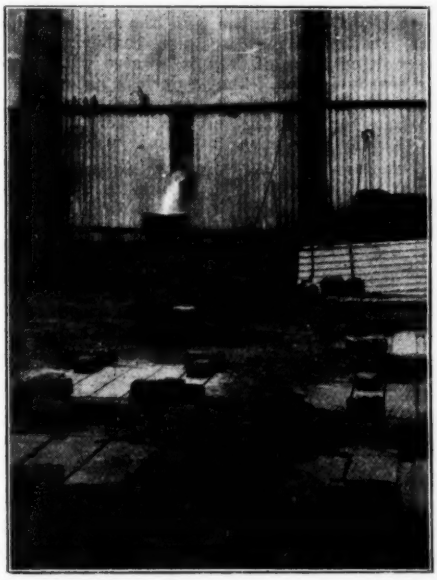


FIG. 5.—CUPOLA SPOUT LADLE AT THE WORKS OF MESSRS. JAS. EVANS (LONDON), LTD.

would be as well to take advice before incurring any very heavy expense owing to the varying conditions, especially where old plants are being renewed.

A short delivery pipe is very much preferred; in fact, it is impossible to get the blast supply too close to the air belt for quick and economical melting. This principle is strongly advocated.

Pressure and volume of blast constitutes a subject to which has been given much thought, but it still does not appear to have reached a final solution. The following views having served the author satisfactorily throughout many tests, there need be no hesitation in recommending them with fullest confidence, and, if faithfully carried through, good results will follow.

Blast Pressure.

Where economical and rapid melting is required, the pressure of blast at the air belt should never, on any size cupola, be below ¾ lb. per sq. in. or 21 in. water gauge, and if it should be a little higher than that so much the better. The reason for this is explained by the contention that with a low pressure it matters not how much volume there may be, the blast merely enters the cupola and creeps up the sides, encouraging the melting to take place on the face of the brickwork or lining, whereas, with a high pressure, the blast has a chance of penetrating to the centre of the cupola and to encourage the melting to take place where it can do the least injury to the lining.

This opinion was confirmed by the vertically-placed centre tuyere cupola, to which reference has already been made. Here was an instance where the general repair of the walls of the cupola was a negligible quantity compared with what is necessary under the more common practice.

Therefore, in the plant illustrated in Figs. 1 and 2 an electrically-driven fan is included, having an 8-in. delivery and running at 2,700 revs. per min., giving a pressure of 21 in. water gauge. The fan is only 20 ft. from the centre of the cupola, and discharges into an earthenware pipe of 12 in. dia. It will be noticed sharp bends are avoided, and where there are branches from the underground pipe to the cupola they are made tapered to eliminate friction and eddy currents as far as possible.

There is no reason why the piping should not be above ground if desired, so long as the principles are the same, nor can there be any objection to the blast entering the air-belt through one inlet instead of two, so long as it is in the proportions outlined, but careful attention should be exercised on this feature, and all chances of air block should be religiously avoided.

Spout Ladle.

Fig. 5 illustrates a ladle arranged on trestles directly beneath the tapping spout. The size of this ladle should have a capacity of at least equal to one charge of materials in the cupola. This will afford the opportunity of getting a complete mixing of the grades as they are melted; it also will allow the smaller hand ladles to be filled and carried away without stopping the flow from the cupola, and whilst it performs the same functions as a receiver, it has the advantage of being much less costly.

Receivers, in retaining the metal that comes from the cupola, also retain the slag, which it is not possible to draw off completely. When the melting has ceased, it therefore sets hard in the chamber, entailing considerable labour for its removal.

With a spout ladle this trouble is eliminated. Obviously, the other advantages are equal.

It is not claimed that the spout ladle is new, and it is only referred to as a part of a complete melting unit.

Fuel Consumption.

The bed charge, of course, cannot be taken into account in a ratio of consumption, because it would be the same whether ten or twenty charges were required, and there is also the quantity recoverable after the melting has been completed. The coke that is put on the succeeding charges has the effect of keeping the bed replenished.

There may be something in the theory recently advanced that the coke should be put on each charge in an even layer, but from experience this is not an easy thing to accomplish, and with charges that are not made too large it does not seem necessary. In conclusion, this Paper having been compiled on an experience not of one effort or size of cupola, but of many, it is put forward with the fullest confidence that if it is fully carried out there can be no failure, and if the saving suggested could be completely effected throughout the whole of the foundry trade, the fuel saving that it would effect would amount to millions sterling.

Publications Received.

"INDUSTRIAL WELFARE, MARCH, 1922." Monthly, 9d. The Offices of the Industrial Welfare Society, 57, Palace Street, Westminster, S.W.1.

THE "MARGIL BULLETIN." The witty house organ of Messrs. Marple & Gillott, of Wharncliffe House, Bank Street, Sheffield. Published for private circulation only.

"THE PRODUCTS OF NOBEL INDUSTRIES, LTD. A booklet giving an indication of the wide interests of the Company, with photographic views of some of the better-known factories. Published by Nobel Industries, Ltd., Nobel House, Buckingham Gate, London, S.W.1.

MESSRS. M. WATKINSON, H. Watkinson, and A. Watkinson, trading as Watt & Company, 22 and 24, Palmer Road, Sheffield, electrical and mechanical engineers, are paying a first and final dividend of 6s. 2d. in the £.

Manufacture of Synthetic Pig-Iron in Switzerland.

Dr. Ing. K. Dornhecker, of Aarau, in an article contributed to a recent issue of "Stahl und Eisen," remarks that the scarcity of pig-iron, especially the lighter grades, such as low-sulphur hematite, was so acute in the course of the war that the manufacture of a substitute became a matter of necessity. The large demand and the small supply of pig-iron and the resulting rise in the price on the one hand, and the lack of high-class ores for the blast furnaces on the other hand, made the manufacturing process appear profitable, which would otherwise never have been considered.

The process in question consists in the recarburisation of scrap of soft iron or mild steel until its carbon content is raised to that required for pig-iron. The process is based on the well-known fact that iron or mild steel, both in the molten and in the strongly heated solid state, rapidly absorbs carbon, almost up to the saturation point. The time and degree for recarburisation depend on many conditions, such as the temperature, the extent of their surfaces in contact with one another, etc.

When recarburising completely decarburised fluid metal by means of powdered coke spread over it the iron at first quickly absorbs carbon. When approaching the saturation point, however, carburisation progresses gradually more slowly, and finally stops. The degree of carburisation obtained in this way is still far from the saturation point, being about 3 per cent. C.

For instance, in a trial run of 1,000 kgs. of material, to which 60 kgs. of coke was added, after 45 minutes a carbon content of 1.83 per cent. was obtained. After another 25 minutes a further addition of coke resulted in 2.6 per cent. of carbon. A still later analysis only gave 2.35 per cent. This was probably due to the top layers of the bath having absorbed more carbon than the lower layers. From this it is evident that in order to obtain good results the carburisation must take place in the furnace up to a certain point only, and the operation must be completed outside the furnace by a special process based on the well-known fact that iron in a solid and highly heated state readily takes up carbon.

The process consisted in mixing the cold mild steel scrap outside the furnace thoroughly with carburising material such as powdered coke, small charcoal, or such like, and in submitting the metal before smelting with progressive carburisation with the help of the waste heat of the furnace.

Two points are to be borne in mind in respect of the size of the carburising medium: In order to obtain the largest contact surface between this medium and the scrap, powdered material should give the best results. However, the strong draught carries the carbon particles out of the furnace, as is shown by the following analysis of the accumulated dust:—C 13 per cent., Si 11.47 per cent., Fe 30.0 per cent., Mn 0.38 per cent., CaO 0.20 per cent.

The special conditions prevailing in Switzerland pointed to the use of the electric furnace for this process. In order to obtain full use of the waste heat to warm and carburise the charge, the furnace was formed as a shaft furnace. The electrodes dipped a certain depth into the charge, so that the heat developed was partly due to an arc over the surface and partly due to the resistance of the charge. It was thus a compound arc-resistance furnace. The furnace is kept continually going by piling more material on the top as the charge sinks. Whilst sinking, the close contact with the carbon and the rising temperature gradually increase the carburisation. As the melting-point of iron is lowered with increasing carburisation, the calories necessary for smelting also decrease. The following table gives the time for smelting and the power in kw.-hours per metric ton, with different percentages of silicon:—

TABLE I.—*Power for Different Silicon Percentages.*

Pig-iron per cent. Si.	K.W.-hours per ton as per meter.	Power used in K.W.-hours after deducting 18 per cent. loss per ton.	SiO_2 reduced Si per cent.	Weight of Si per 1,000 Kg., pig-iron Kgs.	Calories necessary to reduce Si.	Power necessary to reduce Si K.W.-hours	Energy necessary in K.W.-hours to make 1,000 Kgs. pig-iron with sag.	Energy necessary in K.W.-hours to make 1,000 Kgs. pig-iron without sag.
0.65	780	640	—	—	—	—	431.0	360.0
1.6	1,000	820	1.0	10	70,000	81.5	512.5	441.5
3.0	1,240	1,017	2.5	25	175,000	203.0	634.0	563.0

TABLE II.—*Efficiency.*

Si in pig-iron.	Overall efficiency of complete installation.		Furnace efficiency		Overall efficiency of whole installation for pig-iron produced.		Furnace efficiency for pig-iron produced.	
Per cent.	Per cent.	Mean per cent.	Per cent.	Mean per cent.	Per cent.	Mean per cent.	Per cent.	Mean per cent.
0.65	55.0	—	67	—	46	—	56	—
1.6	51.0	53	62	64	44	45	52	54
3.½	52.5	—	64	—	45.5	—	53	—

TABLE III.—*Smelting Time and Power used Per Metric-ton of Pig-iron.*

Si. per	Hours worked.	Quantity of iron dealt with.	Melting-time per ton.	K.W. hours per metric ton pig-iron.	For a charge of 5,000 Kgs. of scrap-iron.				
					Charcoal.	Ground coke.	Lime and Limestone.	Plus spar.	Sand.
0.65	139	138.0	60	780	70	350	60	40	—
1.6	82	77.4	64	1,000	—	700	150	50	50
3.0	79	56.3	85	1,240	—	700	70	50	150

The values in Table I. are obtained from Table III., and the efficiencies in Table II. can be calculated from the values in Table I. As the high temperature of the electric-furnace permitted the use of refractory slags, one could work with a slag containing much lime. Owing to the excess of carbon, this was practically free from easily reduced metallic oxides. The formation of calcium carbide in the slag facilitated the effective expulsion of gases and desulphurisation, according to the formula:—

$$FeS+CaO+C=Fe+CaS+CO.$$

The finished pig-iron always contained less than 0.02 per cent. sulphur; in fact, the low percentage of 0.005 per cent. S. was often found. In spite of its high melting-point the slag was very fluid, and after a short exposure to the air it crumbled to a white powder.

One troublesome feature in working at first was the formation of graphite flakes, even in the case of pig-iron containing only 3.3 per cent. carbon. This was caused by the transformation of the amorphous carbon in the carburising agent into crystalline carbon by the electric arc. This is actually the method employed in the manufacture of artificial graphite. The use of coke in the place of charcoal facilitates the formation of such graphite.

TABLE IV.—*Analysis of Synthetic Pig-iron.*

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
C about	3.5	3.5	3.5	3—4.0	3.4—4.0
Si	0.5—1.0	1.6—2.0	1.8—2.5	3.5—4.0	4.0—4.5
Mn.	0.6	0.6	1.2—2.0	0.8	0.5
P.	0.1	0.1	0.1	0.1	0.1
S. max.	0.02	0.02	0.02	0.02	0.02

Table IV. gives the usual analyses of synthetic pig-iron as made for different orders. Turnings of grey cast iron were also melted in the furnace to produce foundry pig-iron of the following composition:—C 3.2—3.7; Si 1.0—1.5; Mn 0.4—0.8; S.max. 0.02; P. 0.5 per cent. But any other required special brand can be obtained, as, for example, a pig-iron with a low-carbon content, as shown in the following analysis:—C 2—2.5; Si 0.5—1; Mn 0.5—1; P, about 0.1; S. under 0.02 per cent.

The working of the electric shaft furnace is characterised by the strong reducing atmosphere of the furnace. There is no oxygen in contact with the charge, so that, even by greatly overheating, it does not appear possible to increase the absorption of oxygen or carbon monoxide and dioxide. Any hydrogen present is taken up by the calcium carbide in the slag. There can be no question of an absorption of nitrogen, as air does not enter the furnace. The quantity of occluded gas in synthetic pig-iron is also less than in pig-iron produced in the ordinary blast furnace. The following table shows analyses of pig-iron of different origin:—

TABLE V.—*Analysis of Pig-iron Different Origin.*

Quality.	Origin.	Cast	C.	Si.	Mn.	P.	S.
Hematite	English	Sand	3.72	2.87	0.91	0.1	0.03
,,	Oehler	Chill	3.87	2.50	0.30	0.12	0.01
,,	English	Sand	3.4	4.00	1.84	0.1	0.025
,,	Oehler	Chill	3.34	4.12	0.50	0.12	0.008
Foundry	German	Sand	3.8	1.95	0.65	0.57	0.02
,,	Oehler	Chill	3.8	1.82	0.70	0.4	0.02
Hematite	Oehler	Chill	3.9	0.82	0.38	0.12	0.01

Many trials were made to manufacture electric pig-iron from mild scrap in the first years of the war in an old electric furnace erected in 1907. The quality and uniformity of the different tappings did not come up to expectation, but it was not possible to make the necessary alterations to the furnace. It was decided, therefore, in 1917 to erect a special plant for making pig-iron. Two 5-ton furnaces were built and started by the firm, based upon the experiences they had gained.

Of the two electric furnaces built, each of 1,200-kw. capacity, one was to be a stand-by. The current used was three-phase current, 5,000 volts, 50 cycles. The crew consisted of a foreman and three men, who, working in 8-hour shifts, handled about 50 tons of material in 24 hours, with an average consumption of 1,000 kw.-hours per ton of pig-iron, and with six tappings of from 4 to 5 tons each produced from 24 to 30 tons of pig-iron. Each chill contained about 250 kgs.

Tests were made on specimens from every other or every third chill, and the slight differences lie within the errors of analysis:—

TABLE VI.—*Analysis of Pig-iron.*

Cast No.	Chill.	C. Per cent.	Mn. Per cent.	Si. Per cent.
579	I.	3.81	1.98	2.40
	II.	3.83	1.99	2.35
	III.	3.80	2.20	2.40
	IV.	3.88	2.15	2.35
	V.	3.87	1.99	2.38
593	I.	3.86	2.36	2.18
	II.	3.83	2.29	2.18
	III.	3.81	2.28	2.25
	IV.	3.82	2.36	2.26
	V.	3.85	2.38	2.21

Good Drawings and Good Patterns.

By J. DRINKWATER.

A bad type of drawing for one job might be quite a satisfactory type for another job, but patternmakers have often a just grievance against the drawing office because of the quality of the drawings sent down, although it is not always this department that is to blame. When an order is secured by a firm it is imperative that the patterns should be got into the foundries as soon as possible in order to complete the work to contract time, and especially is this so in normal times when there may be considerable delay in getting the castings. When Government work is given out, the first drawings that are sent into the patternshop are nearly always unsatisfactory. It may be impossible for the designer to visualise the finished casting, but there is seldom any excuse for half-a-dozen drawings following one another with alterations each time.

Even in motor shops, when a new size of engine is being made with modifications in the design, the cost of pattern alterations is frequently as much, and sometimes more, than the cost would be of finishing the pattern from a first drawing. It is very questionable if any time is gained by this method, and the resultant pattern is usually inferior because of the way it has been patched. It would certainly be more satisfactory from all points of view if the pattern was not started until the details of design had been determined.

Some draughtsmen are very reluctant to draw more views than are actually necessary. It thus falls on the patternmaker at times, in order to get shapes for cores, to draw sections and scrap views that ought really to have been done in the drawing office. Those little thumbnail views that are a feature in some shops are often of great assistance in elucidating a drawing and save much time. The most objectionable drawing from which to make a pattern is, in the writer's opinion, the arrangement drawing. It is usually impossible to "scale" measurements that are not given, and because of the size it is not possible, as a rule, to set down many dimensions on it. The only time when an arrangement drawing is justifiable from which to make a pattern is when the pattern has to be made to standard sizes and afterwards fitted to place. The arrangement drawing then becomes a picture view, and is very helpful.

The worst class of drawings are made in repair shops. Some repair shops have no draughtsman, while in others the draughtsman is responsible for so many things that he has no time to do any one of them well, and from a rough sketch he makes a drawing which is misleading and frequently inaccurate. In repair shops the patternmaker's ability and initiative are severely tested. It is seldom that more than one or two castings are required from a pattern, therefore the work is usually rough, but the patternmaker, if he does not make his own drawing, has usually to make alterations that, while not weakening the design, will facilitate moulding, while machining has also to be carefully considered.

The best drawing from the patternmaker's point of view is one on which the metal is very clearly shaded, and with full views or scrap views wherever the shape changes. In jacketed cylinders, for instance, this is very essential. It is also a great help when the machined faces are plainly marked. The patternmaker ought to understand something of design; indeed, he should be in great part an engineer, but when a new design is evolved it is not always possible to determine on machined faces. The best drawing from which to work is one on which only one casting is shown, but many things are made clear if an arrangement drawing is also at hand. It is not objectionable, however, in the case of valves if the mountings and covers are drawn in place; indeed, it is very often advantageous because machined faces cannot be overlooked.

Sometimes a grumble is heard because a drawing is covered with dimensions, but it is better for the draughtsman to put too many dimensions down than too few. It is never quite safe, even when working off a full-size drawing, to lift a size by measurement, and when it is done the draughtsman should be notified. A great many mistakes in patternshops are caused by "scaling."

The Early History of Iron with Special Reference to Cast-Iron.

By J. Newton Friend, D.Sc., Ph.D., F.I.C. (Carnegie Gold Medallist).

(*Continued from page* 194.)

As regards the furnace used by the ancient Britons, R. A. Smith* writes: "Although there are various proofs that iron was produced in Britain centuries before the Roman occupation no furnaces of the earliest period have been discovered; and it is therefore probable that the ancient Britons employed the simple low hearth resembling the Catalan furnace of the Pyrenees, which has been in use there from very remote times to our own day. The source from which Britain derived the furnace and art of extracting iron from its ores, seems to have been the Mediterranean region, either the Eastern

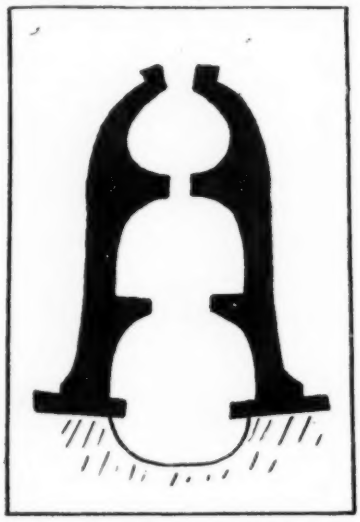


Fig. 6.—The Dyoor Furnace.

Pyrenees or North-West Italy; but it may also be reasonably held that the first iron furnace of the Britons was derived from that used so successfully in the extraction of tin. It is not, however, probable that our islands were the earliest centre for the metal."

Reduction of Iron in Africa.

Schweinfurth,† who during the years 1868 to 1871 was engaged in the exploration of Central Africa, gives several highly interesting accounts of the different methods by which the savage tribes made their iron. The furnace used by the Dyoor —a name meaning men of the woods or wild men —is made of clay. In shape it is conical, as shown in Fig. 6, but the tendency of the clay to crack limits the height of the furnace to about 4 ft. Fragments of ore are thrown into the cup-shaped

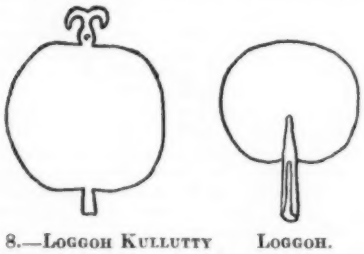


Fig. 8.—Loggoh Kullutty Loggoh.

portion at the top, the lower conical part having first been packed with charcoal. At the base are four openings, one of which is larger than the others, and is used for the removal of the slag, etc. The other three are to admit the long tewel irons, or pokers, which reach to the middle of the bottom, and keep the aperture free for the admission of air. Without stoking the openings would very soon become blocked up with slag. In reply to his inquiry, Schweinfurth was informed that bellows are never employed, as it was found that too fierce a fire was injurious and caused a loss of metal. It would be interesting to inquire if the supposed injurious effect was really due to the production of a little cast iron, which would be unworkable, and therefore a loss to the smelter. When the flames have penetrated through the mass of ore and escape at the top of the furnace the reduction is presumed to be satisfactory. The metal has now sunk down into the hearth, is reduced a second time, and the heavy

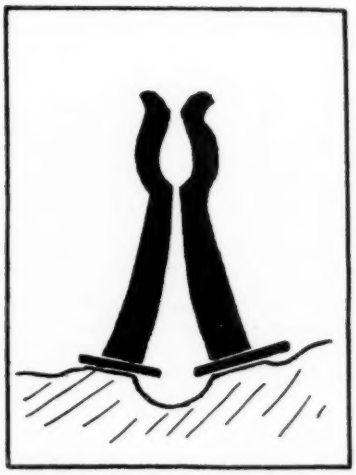


Fig. 7.—The Bongo Iron Furnace.

portion of the resulting product, which is detached in little leaflets and granules, is further heated in clay crucibles. The red-hot particles of metal are beaten into one compact mass with stone hammers, and by repeated hammering lose the

Fig. 9.—Native Knife (Zambesi).

bulk of their impurities. The final product is stated by Schweinfurth to be very homogeneous and malleable.

The usual shape in which the raw material is used as a medium of exchange is in spear heads or in spades. Spear heads are about ¾ yard in length, and serve as currency throughout the Upper Nile. The Bongo, another tribe in Central Africa, prepare their iron in a somewhat more advanced

*R. A. Smith, *A Guide*, etc., p. 4.
†Schweinfurth, *The Heart of Africa* (Sampson Low), Vol. I., p. 81.

manner.* After the harvest has been gathered in and the rains are over the clay furnaces are erected, of a shape shown in Fig. 7. They are 5 ft. in height, and are divided into three compartments, the middle one of which is filled with alternate layers of fuel and ore. The other two contain fuel only. The lowest section has four holes for the reception of tewels, and through which also a blast is applied by means of bellows. A fifth hole serves for the removal of the metal. The raw metal obtained in this way is exhibited in three shapes:—

1. *Mahee.*—Spear heads 1 to 2 ft. in length analogous to those of the Dyoor already mentioned.

2. *Loggoh kullutty.*—The spade-like circulating currency of the Bongo, to which reference has also been made (Fig. 8).

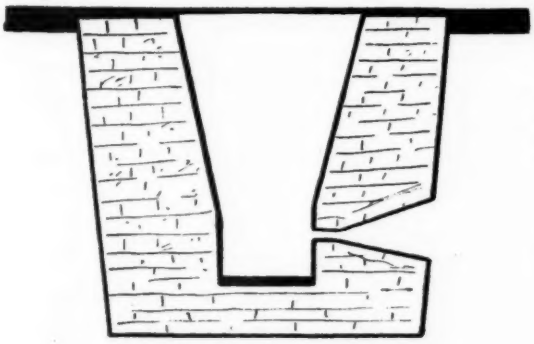


FIG. 10.—THE OSMUND FURNACE.

3. *Loggoh* or *Loggoh melot.*—Spade-like articles resembling the loggoh kullutty, but without hooks at the top. These have a wide sale along the course of the Upper Nile.

The Discovery of Cast Iron.

Returning now to Europe, reference may be made to the Swedish or Osmund furnace, which for a long time was used in the production of iron (Fig. 10), and is ably described by Percy.† The ore, after having been dried by exposure to the air, was calcined in heaps, with wood as the fuel; the calcination was completed in two days. The ore was then smelted with charcoal in the usual way, the average output of iron being merely 1½ tons per furnace per week. In working up the bloom there was considerable loss, sometimes amounting to 50 per cent.

The Osmund furnace was eventually succeeded by the German Stückofen—an ugly name, for which no English equivalent has been given. The name

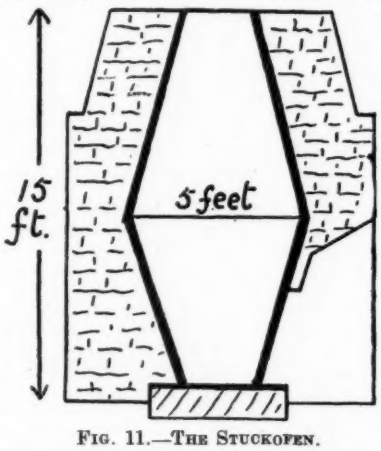


FIG. 11.—THE STUCKOFEN.

originates from that given to the mass of metal or "Stück" extracted from the bottom of the furnace after smelting. This is seen (Fig. 11) to be a lengthened Osmund furnace, bulging in the middle; indeed, it resembles two such furnaces placed one upside down upon the other, and is clearly the forerunner of our modern blast furnace. The taller the furnace the longer the metal remains in contact with the fuel—other things being equal. Consequently, the introduction of the Stückofen led to the production, more or less by a series of oft-recurring accidents, of cast iron. As the height of the furnace increased cast iron became the only product.

As to the exact date when cast iron was definitely recognised one cannot be certain. It appears to have been known in Sussex in 1350, and by 1400 was quite a common product. Sussex was in those days one of the chief homes of the iron industry, its stores of iron ore and wood providing the essentials. It was in the village of Buxted, not far from Crowborough, that

> "Master Hugget and his man John
> They did cast the first cannon."

At first cast iron was used exclusively for casting purposes. Its earliest application was on the Continent, but its use began to be general in this country about 1500. In 1516 a cast-iron gun called Basiliscus was made, weighing approximately 10,500 lbs. In 1588 the Spanish employed both bronze and cast-iron guns in their Armada, and some of these have since been raised from vessels sunk off the coast of Scotland, when the fleet had been dispersed. The production of ornamental cast-iron stove plates reached a high artistic level.

Eighteenth Century Developments.

Many attempts were made to utilise coal for the reduction of iron ores instead of charcoal, but it was not until about 1735 that the problem was

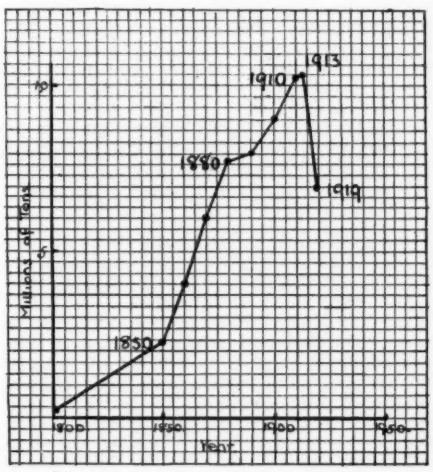


FIG. 12.—THE OUTPUT OF PIG-IRON SINCE 1800.

satisfactorily solved, namely, by Abraham Darby, the younger, at Colebrooke, in Shropshire. Fifteen years later coal became a serious competitor with charcoal. In 1740 there were only 59 blast furnaces in England and Wales, the average weekly output being under 6 tons per furnace. In 1790 there were no fewer than 106 furnaces, 81 of which used coke, the remainder using charcoal. The average weekly output of the coke-fired furnaces was 17 tons per week.* In 1754 Darby† had some seven furnaces, and mechanically-driven engines to supply the blast. The grandfather of this Darby, namely, John Darby, brought over some Dutch brass founders, and built a foundry in Bristol. Here he experimented about the year 1706 with cast iron, endeavouring to obtain castings in this metal, but without success. His Welsh apprentice, John Thomas, thought he saw what was wrong, communicated his ideas to Abraham Darby, the elder son of John, and these two secretly cast the same night an iron pot. For more than a century the secret was jealously guarded, and the process was regularly carried out, at Colebrookdale, successively by John, by Abraham the elder, and Abraham the younger.

About 1740 Huntsman perfected his process of making cast steel—a process still in use—and in 1784 Henry Cort introduced the puddling process. Cast iron was now being used for a two-fold purpose. In addition to casting it found employ as the most suitable starting-point for the manufac-

* Schweinfurth, *loc. cit.*, p. 124.
† Percy, *Metallurgy Iron and Steel* (Murray, 1864), p. 320, *et seq*

* See Summary in *Nature*, 1910, Vol. LXXXIII., p. 265.
† Scrivenor, *History of the Iron Trade* (Longmans, 1854).

ture of iron and steel. Consequently the demand for cast iron increased by leaps and bounds.

Conclusion.

Beginning with an annual output of approximately 250,000 tons of pig-iron, the nineteenth century saw the United Kingdom steadily increase her yield to about 2¼ million tons in 1850. From this date onwards the production increased rapidly to a maximum of 10,260,315 tons in 1913. Then came a rapid decline, the output for 1919 being only 7,398,000 tons. This was due to the war. If we accept the suggestion of Sir Robert Hadfield that the production of iron serves as an index of the state of civilisation, the break in the curve at this point (Fig. 12) clearly points to the demoralising effect of the war upon humanity at large. The author sincerely hopes that, should it ever be his lot to return to the subject, the curve will be found to have rapidly changed its direction and point towards renewed economic and industrial prosperity.

Book Review.

Lehrbuch der Eisen und Stahlgiesserei, by Professor Bernhard Osann. Leipzig: Wilhelm Engelmann, Mittelstrasse 2. (Price, bound, 54 marks, plus 50 per cent. for enhanced cost, plus 100 per cent. for depreciated currency.)

This is the fourth edition of Professor Osann's Textbook on Iron and Steel Foundry Practice. Many things have changed during the war, and had changed even before the publication of the third edition which it was then impossible to introduce. All this has now been put right in the present revised, improved and enlarged issue, in consequence of which several sections have had to be expanded, notably those dealing with cupolas, oil firing, additions of scrap to the charge, gas occlusions, inclusions of impurities, examples from the iron and steel moulding practice, baby converters, graphite substitutes, foundry buildings and foundry calculations.

After explaining the different varieties of steel and discussing the various kinds of fuels used and refractory materials, the author briefly sketches the history of the founder's craft and gives some pre-war statistics Pig-iron brands, direct castings and the various kinds of furnaces in use are discussed next, including crucible and reverberatory furnaces. The cupola has a long chapter to itself, extending to some 86 pages; oil-firing, however, is dismissed in two lines as too dear. The subject of selecting and mixing various pig-iron brands and adding scrap for producing castings for special purposes is dealt with next with numerical examples worked out. Further, three short chapters are devoted respectively to the specific gravity of cast iron, faulty castings and prevention of troubles from occluded gases. As regards internal chill, the author states that this phenomenon gave no end of trouble during the war and led to a regular "plague" of spoilt castings. He attributes the formation of internal chill to various causes, including the low temperature of the molten metal, the use of very rusty scrap and scrap high in sulphur. Whatever the theory may be, says the author, the trouble disappeared when the scrap was carefully picked, casting out all rusty and burnt iron and avoiding the use of thin scrap, setting apart such rejected material for castings of small importance, where its evil influence did not matter much.

In connection with this subject we may mention that a short time ago Dr. Bardenheuer contributed two articles to "Stahl und Eisen," in which he published the results of some special investigations made by himself to clear up the cause of internal chill and advanced a theory to explain it. According to this the mischief was due to the formation of prematurely solidified white iron in consequence of the casting temperature having been too low. The chilling effect, in its turn, was due also more especially to a high sulphur content in the iron. To prove his theory, Dr. Bardenheuer artificially produced castings with internal chill. His theory was challenged by Professor Osann in a contribution to a later issue of "Stahl und Eisen," but Dr. Bardenheuer maintained the accuracy of his own theory in the same issue and defended it also against the criticisms of Dr. Hans Frei, of Zürich, in the "Giesserei Zeitung." Professor Osann maintains that the high sulphur content is not sufficient to explain the phenomenon.

To return to the book under review, the author next discusses the subjects of contraction, internal stresses and permanent deformations (warping, etc.) due to these and annealing as a remedy; the permanent growth of cast iron by repeated heatings is also touched upon.

Piping in ingots, etc., is considered next, and the physical tests for castings both of iron and steel are examined (with some extracts from specifications) and their correlation with their chemical analysis, with special regard to silicon, manganese, carbon, etc., content.

Having thus reached page 258, eight more chapters are devoted to moulds, moulding machinery, practical examples of preparing moulds for various kinds of castings, pipe-founding, permanent moulds, chilled castings, flasks and the preparation of moulds for teeming. Drying processes and appliances are dealt with, next followed by a discussion of materials used by the moulder and the recovery of iron from the cupola slag, foundry scrap, etc. A chapter on foundry ladles follows next.

The next two chapters deal with the production of steel castings and malleable iron castings, followed by another on cleaning, dressing and fettling. A special chapter is devoted to repairing and making good broken and faulty castings by the use of thermit, the electric torch, oxyhydrogen welding, etc.

Hoisting and lifting appliances and transport means are considered in the next chapter, followed by another dealing with the arrangement and lay-out of foundries with examples taken from actual practice and numerous references to descriptions of others in Germany, France, the United States, Russia and other European countries. Many of the descriptions in the book are fully illustrated with plans, elevations and sections to scale.

Foundry estimates and the metallography of cast iron are dealt with in the last two chapters. As will be seen by this cursory description of its contents, the book is a comprehensive encyclopædia of the founder's craft, which has been written for both students and workers in actual practice in the foundry.

How Moulders Mould.

It is well said that the one half of the world does not know how the other half exists, but after a perusal of an article which recently appeared in a contemporary, there is no reason why the world at large should not be fully *au fait* with the details of the moulders' craft. The description is couched in the following terms:—

"It is because the moulder casts, or moulds, hundreds of thousands of small parts of machinery required by a variety of trades that the recent strike threatened to paralyse industry.

"His work consists mainly of pouring liquid iron into moulds prepared for him by pattern-makers, but considerable skill is required in using the moulds and turning out the metal parts required.

"In most of the big foundries there is a pattern-makers' department, the moulders being roughly divided into two classes — ordinary moulders and 'core-makers.' For pipes and other tubular things a double preparation is necessary, for a core must be put in the centre of the pipe-mould to keep the passage clear. The cores are made of clay and dried in the furnaces, and sometimes wrapped in straw. The hot iron burns off the straw, but the straw keeps it from sticking to the core. If many castings are required a brass or iron mould is prepared.

"It is the moulder who, as he pours the hot iron into the moulds, has to keep them in position, so that the pattern is turned out exactly as required. This is done with the aid of damp, green sand, which he banks round the moulds, or boxes, which are clamped to maintain their stability.

"One of the most interesting sights in the moulders' shed of an iron foundry is to see the workmen carrying the molten metal from the furnaces to the casting beds in clay-lined pots swung on a lever. When a great quantity of metal is required it is carried along by means of an overhead trackway from which the pots are suspended."

The Problem of Grey Iron Castings.

By H. J. Young, F.I.C.

THE DISCUSSION.

At a joint meeting of the Institute of Mining Engineers and the London Branch of the Institution of British Foundrymen, held on January 24, Mr. H. J. Young's Paper on "The Problem of Grey Iron Castings" was discussed.

THE CHAIRMAN (Mr. F. M. Timpson) announced at the outset that the slides would first be shown on the screen, in order that Mr. Young might afford those who were unable to be present at the reading of his Paper in December a summary of his discourse.

MR. YOUNG then showed the slides, remarking that he did not propose to go deeply into the Paper, as it took two hours on the last occasion. Amongst the points emphasised by Mr. Young was the great difficulty in getting a test bar which truly represented the casting from which it was taken. He further emphasised his statement that in most cases where bad castings have been produced, the cause has been unbalanced sulphur, and that by controlling the proportions of sulphur and managanese, much better results could be expected.

THE CHAIRMAN, in opening the discussion, remarked that it came at a time when all were looking for more light on foundry problems.

MR. W. MCLAREN thanked the author of the Paper for having come so far (from Wallsend-on-Tyne) a second time in order to enable his subject to be more thoroughly discussed. He noted with satisfaction that at the present time many firms were demanding careful analyses of both the iron used and produced in their foundries. As far back as the seventies experiments had proved the unreliability of cast iron, and even to-day there remained a great deal of research work to be carried out before we could produce the right quality of castings to meet the demands of internal combustion engines and the high temperatures generated in the cylinders.

Bricks Need Standardizing.

MR. FAULKNER (Hon. Secretary of the London Branch of the Institution of British Foundrymen) thanked the Institute for inviting the members of his Institution to be present, as the Paper was one of peculiar interest to them. He described it as a very pessimistic Paper, and contended that present-day research was advancing scientific control in the foundry to a very material extent, perhaps not so rapidly as was desirable. He made appreciative reference to the closely agreeing results obtained in the foundry with which Mr. Young was associated, as shown by Table VI., and he wished to know more of the methods by which Mr. Young achieved those results. As regards the elements of uncertainty with which foundrymen had to contend he mentioned that as recently as January 5, Mr. C. M. Gill, M.I.Mech.E., of the South Metropolitan Gas Company, had pointed out in a Paper presented before the Institution of Mechanical Engineers, that the length of a firebrick may vary half an inch in length and a quarter in breadth and thickness. If special sections vary similarly, cupola troubles, accompanied by metal difficulties can be expected. Mr. Young's opinion as to whether cause of the white hard spots showing structure of a casting which had been brought there that evening, could be ascribed to unbalanced sulphur. It was by no means a freak, but a casting such as is being requently encountered in the foundry. He certainly did not think that the appearance of internal white spots were due to unbalanced sulphur, as Dr. Osann had studied a case where the sulphur was 0.10 and the manganese 0.80 per cent., which latter is more than sufficient to balance 0.10 per cent. of sulphur.

MR. W. LAMBERT (Vice-President of the London Branch of the Institution of British Foundrymen and Member Inst.Mar.E.) thanked Mr. Young for his Paper on behalf of foundry metallurgists, of whom he was one. He was in total agreement with the author's remarks on sulphur-manganese balance. The amount of sulphur originally contained in the pig-iron was not reduced at all; it was largely increased by sulphur absorbed from the fuel, and from analyses was seldom less than 0.075 of the total constituents. Sulphur segregates out from the iron, but provided the segregations are well distributed, it has but little harmful effect. He had studied Mr. Young's data as given in the Paper, and he could quite reconcile the figure with results obtained during his own experience. He would like to ask whether the author recommends adding the manganese by manganiferous pig-iron or by ferro manganese additions to the ladle, particularly when the castings were required to possess the properties demanded by the makers of internal combustion engines. In the old days at Woolwich, when he was engaged in the casting of iron cannon, various grades of pigs were selected and put through the cupola before running into cannon. He was wholly with the author in his statement that it would be necessary to know much more than is known at present about casting iron in order to reduce the weights of castings. He looked forward with confidence to the progress which would be made as a result of the work of the British Cast Iron Research Association, especially in view of the fact that they were investigating their problems in actual works foundries, and not in laboratories. It was useless to attempt to draw practical working conclusions from pure laboratory research; data must be obtained from actual castings, weighing perhaps several tons. He need only cite one instance to illustrate this; he referred to Fig. 1 in the Paper, which showed the micro-structure of the different parts of the large marine propeller shown by the author that evening. A professor in his laboratory could not possibly get such photographs, taken as they were from the blade and the boss of the actual propeller. In connection with the difficulties confronting the foundryman, he thought it should be borne in mind that the pig-iron manufacturer also found his work bristled with difficulties. The blast of the furnace is fed with atmospheric air, which varies very considerably, as for example in the moisture content. One hundred and twenty-six gallons of water per hour, in the form of moisture, pass through a blast furnace. The varying conditions caused by changes in the atmosphere may, and do, have a very important effect on the results obtained from the cupola. After all, when one considered the large number of constituents in cast iron, he did not think one could wonder at the variations which occurred in castings. Grey iron contains 340 times its own volume of gas. Apart from the elements shown in the slides, there must be the influence of that large volume of gas which is shut up in the iron.

MR. SLATER (London Branch-President of the Institution of British Foundrymen) said he was struck rather forcibly by the all-round confession by experts, whether practical men in the foundry or chemists, that they knew nothing about the science of casting iron. Referring to the advantages claimed for re-melting, he gave an instance from his own experience several years ago, when he was dealing with a consignment of pig-iron, which when broken had the appearance of being largely composed of graphitic flakes. The ordinary methods of mixing and melting were found to be unsatisfactory. He then tried melting in an oil-fired crucible, and found that the grain had closed up considerably. After re-melting by this process four times a maximum strength of 14 tons tensile was obtained, the iron being afterwards turned into castings with excellent results. He mentioned this as one example of the foundryman obtaining the desired results by re-melting and thereby closing the grain of the castings. But what the iron picked up in this process of re-melting he was not sure about. He would like to know if the information was available.

MR. J. H. GRAVES said the chief lesson he had learned from the Paper was the need for a closer co-operation between the chemist and the engineer, particularly during the actual carrying out of research work, at which the engineer was seldom present. He thought the author's description of cast iron as unreliable, should be restricted to certain cases only, as for some purposes it was

* This Paper was originally presented to the Institute of Marine Engineers on December 13, and appeared in the December 22 and 29 issues of the FOUNDRY TRADE JOURNAL.

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reliable enough. He did not agree that our leading technical institutions teach little about the production and properties of cast iron. Referring to an incident quoted by Mr. Young, he certainly thought it extraordinary that a representative of a firm of pig-iron makers should be absolutely at a loss to say why—when questioned on the point—his particular brand of iron was excellent for Diesel engine castings.

Mr. Cleaver asked whether the author could give the reasons why the micro-structure at the various sections of the propeller shown in the photograph were different at each section. He would also like to be further informed as to the best proportions of sulphur and manganese. He noticed from several of the lists of figures that the ratio 2 of manganese to 1 of sulphur appeared to give fairly good results. He had thought previously that the best ratio was at least 4 of manganese to 1 of sulphur. He would like to know whether the strength of an iron casting was increased or reduced by repeated heating and what changes took place in their consistency. On studying Mr. Young's results, which were very commendable, he had wondered whether in his foundry shop scrap was used as a base and pig-iron being used only to improve the metal, and in what proportion, as the pig-iron analyses were so valuable. Also could Mr. Young give any figures to prove that a silicon content of 1.7 per cent. gave a close-grained iron suitable for high pressures, in thicknesses varying from 1 to 2 ins. What silicon base would he recommend for such work?

British Pig-Iron Preferred.

Mr. H. G. Sommerfield spoke in appreciation of the lecturer's Paper, and particularly emphasised the truth of his remark that "to purchase an iron upon its published composition is to buy a pig in a poke." Instances, and they were not at all uncommon, had been shown of the rather extreme analytical variations experienced even in the same consignment of an ordinary graded iron. It was obvious, therefore, that pig-iron, which had a reputation for regularity and reliability by virtue of its special selection would offer more safeguards to the foundryman. He presumed that in Table II. of the Paper the percentages of silicon and sulphur, as set down, did not represent the findings in one and the same pig. As regards sulphur and manganese he did not think the former should be the bogey it is alleged to be. He recalled a locomotive cylinder which had been in constant use for twenty-three years, and had only once been rebored. When this was dismantled and broken up the analysis showed sulphur to be 0.219 per cent., phosphorus 0.905 per cent., manganese 0.4 per cent., and silicon 1.6 per cent. Sulphur had not therefore proved of much detriment in the casting, and indeed it seemed to be quite a common experience to find castings of a generation ago much superior as regards wearing qualities to castings of modern-day production.

The question of re-melting pig-iron must remain a very open one. It is well known that sulphur would be absorbed in the process, and if it were essential to keep this element low, re-melting should be avoided. Re-melting would reduce the silicon and increase density, and might in some instances be useful.

Referring to the question of the best iron for Diesel cylinders, Mr. Sommerfield cited the case of a Continental works who invariably preferred English irons to the best Swedish charcoal qualities, even though the latter were low in phosphorus, and, generally speaking, regarded as very pure. The heat and fluidity imparted by a well-regulated percentage of phosphorus secured an appreciation for English irons over the sluggishness noted in the Swedish.

Mr. Hall agreed with Mr. Young's statement that the foundryman was working in the dark, without the guidance which science afforded to other trades. He wished Mr. Young had dealt more with the general run of castings for jobbing work. His experience was that when the engineer complained that castings supplied to him were hard and could not be machined, the foundryman retorted that it was due to the engineers' tools being faulty, but this satisfied nobody; what was wanted was exact knowledge of what occurred in the foundry processes so as to enable them to control the product. At present he only knew when castings were good or bad by breaking and examining samples. Science must be brought into the foundry if the desired progress was to be secured.

The Author's Reply.

Mr. Young, in reply, expressed his thanks for the kind remarks which had been made. He thought Mr. McLaren's idea was that the chemists should deal with the iron ore rather than the iron as cast. He totally disagreed with that idea; the ore was a natural product, and they had to buy pig-iron as it was sold, and make the best of it. Mr. McLaren had also spoken as though there had been a great deal of research carried out on cast iron. He (the author) had searched very thoroughly all available records on the subject, and had found very little in the nature of original research. He knew of a recent instance when the secretary of a scientific society had been asked to name some books which would give photographs of cast-iron sections, and after searching carefully he had failed to discover any such books.

Mr. Faulkner's question inferred that he, the lecturer, had been able to obtain better iron than other people; that was not true, as there are other people getting good results, though they were few. He deplored the preservation by practical iron-foundrymen of so-called "secrets," by which they were supposed to obtain good castings; there were no such secrets. He had sometimes found these secrets to be the contents of a very ancient note-book. Foundrymen, chemists and engineers should frankly admit that they know very little about the science of cast iron, and then they would soon begin to make real advances in that knowledge by working loyally together with a common aim. His own results were simply the outcome of hard work, and that was all that was necessary. Frequently the chemist was too much under the direction of the engineer; that was wrong, the chemist should be given a free hand, and if he did not get results he should be dispensed with, and another man tried. A remark was made at the previous meeting about England being full of "tame chemists." To some extent he agreed; a chemist in works needs to be a live man or he is useless.

He appreciated Mr. Lambert's remarks as those of a chemist and metallurgist. They wanted to make it clear that the foundryman could not by himself effect the desired control of sulphur, manganese, silicon, etc., but he must work in conjunction with the chemist to that end. Sulphur affected, to an important extent, castings required to withstand high temperatures. Mr. Lambert had spoken of the influence of the many other elements in cast iron, but he thought it was enough to attempt at present to study what influence the more common elements have on the iron, and they could pass on to oxygen and others when they understood the former.

Mr. Slater had asked why the grain of cast iron was so closed up by remelting. This information was readily obtainable from the numerous works published on the subject, and he urged foundrymen to study more earnestly. The reason was that the proportion of silicon, carbon and manganese was lowered and that of sulphur raised by the re-melting.

He regretted Mr. Graves had not added the facts on which he based his remark that cast iron was not an unreliable metal. He (the lecturer) had given reasons to prove his own statement that cast iron was unreliable; for example, the engineer's high safety irrespective of the strength of the iron. Also many castings are much heavier than they need be, simply because cast iron is unreliable. Again, in many cases steel castings were being used to-day instead of iron, for the same reason. As regards the speaker's views as to the teaching of the metallurgy of cast iron, he might mention the Newcastle district, where there was little or no teaching given on this subject. Students come from the colleges knowing practically nothing about the metals of commerce; they had not even been taught that there was much to know.

Mr. Cleaver had asked whether the differences in the sections of the propeller blade as shown in the photographs were due to sulphur. They were not, but were merely due to the different thicknesses and environments of parts of the casting and the consequent different rates of cooling. If test bars were made from the same metal, one 1 in. and the other 2 in. in thickness, they would give

different results. The reasons were explained in his paper. In reply as to the question as to whether the best ratio of sulphur to manganese was 1 to 4, he did not know; that was one of the questions they had to determine. As to how repeated heating and cooling of iron weakened the casting, research had been carried out in the matter and could be found in scientific journals. Mr. Cleaver also asked whether one could guarantee getting good castings by means of silicon control. He (Mr. Young) thought that was possible, if the foundryman could control the silicon and keep the other constituents right at the same time. The foundryman could not attempt sulphur control without the aid of the chemist, and consequently would do best to leave it alone and run on low-sulphur irons.

Mr. Lambert had asked if he used ferro-manganese. The answer was that if one required more manganese the only satisfactory way to get it was by using pig-iron of higher manganese content; on the other hand, when melting steel in the cupola, it would be advisable to add some ferro-manganese to the ladle—which information was exceedingly common and well-known practice.

The last speaker had regretted that he had not said much about ordinary commercial work. He was under a misapprehension, for most of the Paper dealt with ordinary commercial work. He wished to correct any impression that his Paper dealt exclusively with high-class castings.

Referring to the bad casting which had been brought forward that evening, it was plain what was the matter with it, but to tell what was the cause was another question. He would be pleased to examine and report on it if the maker of it would tell him how he made it.

THE CHAIRMAN, in expressing satisfaction with the excellent opportunity they had had for the discussion, reminded those present that Mr. J. T. Milton had read a very interesting Paper on the occasion of his induction as President of their Institute, dealing with the progress of research in connection with marine engineering materials, including cast iron. He congratulated themselves on having had such an able authority to lecture to them at a time when it was becoming so necessary to acquire definite knowledge of this important subject.

MR. GEO. ADAMS proposed a vote of thanks to Mr. Young. He thought they would all agree that he had got down to the bedrock of the subject in his excellent Paper. That Paper, backed as it was by Mr. Young's practical experience, provided much food for thought, and certainly showed the importance of scientific research. Such research was called for to-day in every trade in which this country was concerned. By means of such research our competitors on the Continent had captured trade which should belong to us. He contrasted the inadequate extensions which had been made to foundries during the war with the extension of machine shops. Since the war there had been an even greater neglect of the foundries, owing to the shortage of money which might otherwise have been spent on improvements. The country must endeavour to remove the condition of stagnation as regards knowledge in the foundry; their present scanty score of knowledge was based entirely on practice and rule of thumb. He was rather anxious to know how the small foundries would manage in the future; he referred to those firms who would be unable to afford to have a chemist on their staff. The difficulty would be lessened if the foundrymen themselves acquired more scientific knowledge, as Mr. Young had suggested, by reading as much as possible on the subject from books and lectures. The only firms to-day who could be relied upon to supply machinery or materials to strict specifications were those who based their methods on scientific principles. That was abundantly evident to members of their Institute from their experience with the machinery of vessels turned out by various firms. Mr. Young's Paper was so full of useful knowledge that they could go on for a long time with the discussion. Coupled with his vote of thanks to Mr. Young he would like to thank those who had taken part in the discussion.

MR. MAYOR seconded the vote, which was carried with acclamation.

MR. YOUNG, in responding, wished to make it quite clear that his Paper was in no sense directed against the foundryman. He considered that the foundry had been starved in the past, while the education on the foundryman had been utterly neglected. In the past an engineer would readily spend several thousand pounds on plant for the machine shop if he thought it would increase the efficiency of that department, but he would hesitate before he would spend as many pence on better equipment for the foundry. He (the lecturer) thought it wonderful that the foundryman had got as far as he had, in spite of the lack of facilities, encouragement, and finance.

Contributed by Correspondence.

Mr. H. J. YOUNG: It will be remembered that Mr. George Hall brought up the question of a defective casting, produced at the meeting, and wanted to know the reason of its mysterious failure.

The casting in question is a small bedplate, weighing about 2 cwts., and of which the sections vary between ⅜ in. and about ¼ in. The trouble consists of what has been described elsewhere as "internal chill," namely, some of the metal in the centre of the body of the casting is white or nearly so.

The composition of the casting is as follows:—

	CARBON						
	Combined	Free	Total	Sil.	Phos.	Sulph.	Mang.
Grey Part ..	0.56	2.39	2.95	2.24	1.53	0.135	0.39
White Part ..	1.97	0.95	2.92	2.23	1.52	0.144	0.39

Readers will have noticed in the "Foundry Trade Journal," dated February 2, a long article upon the "internal chill" in grey iron castings and an investigation upon same by Mr. W. H. Poole. In every case quoted by Mr. Poole the sulphur-manganese balance is at fault, and the article says "Mr. Poole has successfully overcome this trouble by increasing the manganese content in the mixture." The author's paper says as follows:—"Practical men know only too well the metal they describe as 'hard iron'—metal possessing every undesirable property, including weakness and brittleness . . . the 'hard iron,' the *bête noir* of foundries and of engineers, is a product of ignorance or of misfortune—foundries have ever been prone to sudden mysterious spasms of bad metal or bad castings—in every such case in the author's experience the iron has always suffered from inadequately-balanced sulphur—no matter what the quantity of sulphur, that of manganese must be more than sufficient to balance it—if you put 'hard' unbalanced-sulphur iron into an intricate casting then that casting will be extremely likely to fail, possibly a few minutes after the metal enters the mould, and in any case the metal would be poor and brittle and have bad machining properties."

The author quotes the above extracts from his own paper in order to prepare the way for his opinion upon the case of this defective bedplate casting sent by Mr. Hall.

In ordinary foundry work a sulphur content of 0.144 per cent. together with a manganese content of 0.39 per cent. in the finished casting would appear to the author to be amounts bordering on the danger zone, but not in themselves dangerous. It would seem to him, however, that while this may apply to irons containing carbon about 3.3 per cent. (or more) and phosphorus about 1.2 per cent. (or less) the same does not equally apply to irons, particularly if poured at a low temperature, containing carbon about 3.1 per cent. (or less), and phosphorus about 1.4 per cent. (or more). He would think that a wrong sulphur-manganese balance is even more fatal to low-carbon-high-phosphorus irons and that it takes even more manganese to balance any one particular amount of sulphur than in the case of ordinary foundry irons.

Mr. Hall's defective casting was made from crucible-melted metal, and therefore no question of cupola practice comes into consideration.

The author recommends Mr. Hall to do two things, firstly, to raise the manganese content in his mixture and, secondly, to investigate from whence arises the very undesirable low carbon, high phosphorus and high sulphur content of this casting. In Mr. Hall's case, where crucible-melting is the practice, it would not appear difficult to eliminate the trouble once and for all, and the author is communicating with Mr. Hall on the point.

Institution of British Foundrymen.

LANCASHIRE BRANCH—(Burnley Section).

Discussion on Mr. J. Masters' Paper on "Oil Sand Cores: Methods and Mixtures." *

MR. J. PELL, in opening the discussion, said there were members present who proposed investigating this matter, and it would be of use to them if Mr. Masters would indicate what compound or oil he used, and in what proportions. Would the proportions be the same whether it was for a heavy or a light casting. He had used oil sand cores for castings of uneven sections, but without success. What did the lecturer consider to be the thickest section of metal with which oil sand cores could be used. In this case mentioned it was 6 ins.

MR. MASTERS replied that the name of the oil he used was "Fax." The proportions, as stated in the Paper, 1 part of oil to 9 parts of water and 45 parts of sea sand, were for general use, and sufficiently good for practically any class of work. It was used for cylinders up to 7 tons weight, and 4½ in. thick on some of the sections. The cylinders were cast on and were as high as 10 ft. as cast. For a metal thickness of 6 in., however, he would not advise oil sand cores. For such work a loam core should be used, with 1/60th part of oil added, as under any circumstances oil would be beneficial, and even though the casting weighed 15 or 16 tons, he would mix oil with the loam sand. A coating of blacking would have a protective effect. He gave the following formula for a loam sand mixture: 1 pint of oil, 6 shovels of red sand, 2 shovels of road sand, 2 shovels of horse dung, and 4 shovels of old sand; all to be milled in the usual way.

Questioned as to the method of mixing, Mr. Masters said at present he did not use a mixing machine, but he hoped to have one when the prices became reasonable. The method adopted was to put the required quantity of sand, measured, in a heap on the bench. The oil was rubbed in so that it covered the grains of sand in order to get a better binding effect. Then it was passed through a riddle. Afterwards water was added. Then it was rubbed through the riddle again and was fit for use.

MR. PELL described a furnace door proposition in which there were a lot of slots. It was a very delicate casting, only ⅛ in. of metal over the top. With loam sand it was a failure, although the core was vented with wax vents. There were 25 per cent. bad castings. Afterwards they tried oil sand cores, and they obtained the plates made to the shape of the core and the box made to the shape of the plate. There were then about 2 or 3 per cent. wasters. But he did not think the trouble was due to the cores. It was due to the metal not being put in hot enough.

MR. HILTON said in the case referred to by Mr. Pell he did not think it was the oil sand core which failed; it was the core iron which was made for it. It was a single iron, and the core being 12 in. broad in plates, the iron, instead of strengthening the core, really helped to part it.

Fig. 1 shows the casting with the position of the core outlined in chalk.

The casting is 5½ in. and the core 2 in. thick, giving a thickness of 1⅛ ins. of metal on both top and bottom of the core.

The 6 holes shown in the illustration were used to bring the vents through from the main core, and were afterwards plugged up.

MR. MASTERS said they had now got to the stage that the men could handle the oil sand cores without any difficulty, and they grumbled if they had to use a loam sand core. It was practically impossible to get blown castings with oil sand.

Reference was made to various specimens of castings. Mr. Masters said where the thickness was only 3-16 in. or ¼ in. he advised reducing the proportion of oil; one part of oil to 60 parts of sand would be quite good. There was no difficulty with regard to the core coming away even if no vent was put in. There was no necessity to put a vent in if the core was dry. He did not like wax vents, and would not use them. To prevent the oil sand from clogging the core boxes, they wiped the core boxes constantly with paraffin, but in any case the boxes should be originally well varnished.

The oil sand cores could be used for phosphor-bronze, gun-metal, and aluminium. It was usual to apply a coating of blacking, consisting of 2 parts mineral blacking or plumbago and 1 part of china clay; there was nothing else in the mixture except water. Oil sand took a longer time to dry than ordinary core sand, but that was a matter of adapting oneself to the job. If it was burned it lost its binding power.

MR. PELL asked what was the lowest temperature at which oil sand cores would be burnt. He had always understood that a stove heated to 270 deg. or 315 deg. C. was sufficient to dry either oil- or loam-sand.

MR. MASTERS said it depended upon how long the heat was maintained. The greatest trouble was in lifting oil sand cores, especially if they were still damp. If air could not circulate around the core it did not dry, and if the core was lifted whilst slightly damp and the air got to it, it produced quite hard skin underneath. To overcome that difficulty when making special cores, special plates were made, with as many holes in as possible. A layer of paper was spread over the plates, which, when burned in the stove produced circulation of heat underneath the core as well as on the top. Many cores were lifted and turned over. If one burst it was filled in and replaced in the stove. One advantage of oil sand was that if the cores happened to burst and the inside dropped out, the core was simply turned over, damped, a drop of oil added, filled up with oil sand, and baked for another night in the stove. But oil sand cores cannot be mended with loam.

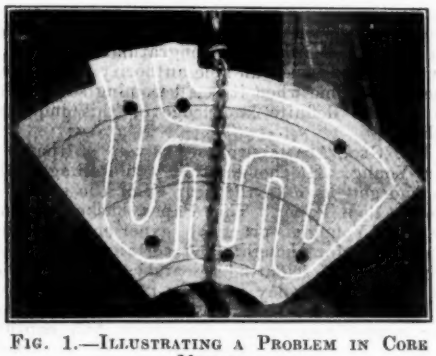

FIG. 1.—ILLUSTRATING A PROBLEM IN CORE MAKING.

Describing the method followed when casting pulleys, Mr. Masters said it did not matter whether there were 10, 20, or 50 grooves. It was not necessary to use any irons except a grid just sufficient to lift the core off the carriage. If he were making a big pulley for a large engine he would make two tiers of cores, and instead of having one box, there would be two, one on top of the other. It was much better than the old-fashioned method. If he were making a small diameter pulley with 6 or 8 sheaves he would simply make 1 sheave at once and build it up to required number.

A question was put as to whether the sand could be used more than once. Mr. Masters replied in the affirmative, but explained that that which went to the fettlers could not be used again with advantage except as parting sand. He had employed used sand many a time without any detriment. Some people said they found it detrimental, but he thought the reason was that they had not mixed the sand properly. Sea sand in its raw state was very high in silica, and after it had been used it was purer than previously. If oil sand was used in a foundry there were few scabbed castings. Oil sand which was not used one afternoon could be used the next morning, the practice being to put a damp bag over it. On the point of cost, the oil sand was cheaper than the ordinary loam sand mixture when the various advantages were taken into consideration.

* This Paper appeared in the March 2 issue of the FOUNDRY TRADE JOURNAL.

THE CHAIRMAN said he had some experience of the use of linseed oil, and at one time he thought there was nothing so good for the pupose. It was certainly better than some of the compounds that were on the market. But the great objection to it was the smell and the smarting effect upon the eyes of the men. One foundry where 30 or 40 moulders were employed on making castings in connection with which linseed oil was used, the men made such strong complaints that it had to be dropped. He had no personal experience of the oil Mr. Masters used, but he had heard good reports of it.

He thought the heating of the stove should not exceed 315 deg. C. Anyone using oil sand cores should have a pyrometer in the stove, as fuel varied so in quality. On one occasion a load of coke from a gas works might be nearly all dirt; at another time it would be quite good. Under some circumstances a labourer might not get more than 150 deg. C.; the following night the temperature might go up to 370 or 425 deg. C. Obviously anyone working under such conditions with oil sand was asking for disaster. To his mind the best stove on the market was the hot-air stove, with which one got practically the same heat every night. There was not too much heat and it was reliable. It could be whitewashed and made to look very nice and clean.

He noticed that the lecturer was very careful about his core boxes. That was an important matter, as some core boxes were very poor; evidently the men who had used them were not under proper supervision, and the boxes were left half cleaned, so that the inside became like a piece of rough emery cloth. Anyone employing oil sand should insist upon the moulder cleaning the boxes out every night.

According to the lecturer no scabs were found on castings that referred to the inside, as obviously an oil sand core would not prevent a casting scabbing outside. Even when sea sand had been well mixed by hand and the temperature was correct he had observed shell scabbings.

Foundrymen knew that the usual red sand was not always of the same quality. If it came from a fresh place and was taken from the surface, where it had been exposed to the weather, the foundryman was in for a bad time, and there was scabbing on the casting. Did similar conditions obtain with sea sand?

MR. MASTERS said he had the same experience with linseed oil—the nasty smell accompanied by the smarting of the eyes. During the war, when they were glad to get any kind of oil which would answer the purpose, linseed oil was one of the staple things that could be got with a permit. During this period a man was employed constantly going round lighting vents after moulds had been cast. But he noticed that none of their employees had a cough or cold during the time the linseed oil was used. Perhaps some of the trouble experienced was attributable to the husks and other debris mixed with the oil.

The occurrence of scabs could be explained if Mr. Hogg was using sea sand. Possibly it came from a patch containing a fair amount of shell, and if shell from the sea-shore was present in any quantity, small scabs would occur because as soon as the heat acted upon it the calcium carbonate became decomposed. Sometimes, however, scabs were caused by the core-maker sleeking too much. It was not advisable to sleek it more than was necessary. Good methods were to go one way round and finish it and then leave it, or to put on more than sufficient and rub off the excess afterwards.

The Birkdale sand, which was a main source of supply, was well away from the coast and had been blown there or deposited many years ago

Undoubtedly the hot-air stove described by Mr. Hogg was ideal for core baking.

MR. PELL said cores could not be blacked when in the green state. It is necessary to wait till they have dried to a certain extent, during which time they are liable to get burned.

MR. MASTERS replied that even if the core was slightly burned no real difficulty was experienced. If a little oil was used with the blacking it seemed to recondition the cores again. Finally, with regard to cleaning core boxes, he agreed with the Chairman that unless this was carefully carried out it was better not to use oil sand.

NOTES FROM THE BRANCHES.

London.

Mr. R. Greenwood (member) has been appointed works manager to the International Combustion Engineering Company, Limited, of Derby.

Owing to unforeseen circumstances it has been found necessary to postpone M. Ronceray's lecture. Mr. H. R. Bartlett has kindly consented to fill the breach. The programme now reads:—April 19, Mr. Bartlett on "Moulding Machine Practice," preceded by a general meeting at 7.30. April 26, Mons. E. Ronceray on "Making Castings without Feeding Heads."

Newcastle.

The John Surtees Memorial Fund having now passed through all legal and technical stages, is now available for competition. Officers have been elected to administer the Memorial Fund as under:—J. D. Carmichael, chairman; R. Wallis, M.B.E., Wh.Sc., vice-chairman; all past presidents as Governors; H. A. J. Rang, hon. secretary. This branch has the honour of inaugurating the Memorial this year. Particulars of the competitions will be announced later.

West Riding of Yorkshire.

The Branch is now well established. It had its inaugural meeting on November 30 at Bradford, when addresses were given by the President, Mr. Oliver Stubbs, and the Honorary Secretary of the Lancashire Branch, Mr. J. Hogg. A council was formed, with Mr. A. A. Liardet as Branch-President and Mr. Thos. H. F. Johnson as Honorary Secretary. Up to date four meetings have been held, at Bradford (two), Leeds and Keighley.

The first Paper was "Some Perplexing Foundry Problems," by Mr. J. Shaw, of Sheffield. Mr. Poole, of the Keighley Laboratories, was the lecturer at the second meeting, and took for his subject "Pig-Iron and Their Fractures." Mr. J. S. Robinson, of Halifax, taking as his subject "Moulding a Gas Engine Cylinder," was the lecturer for the first meeting held at Keighley..

The first meeting at Leeds was held last Saturday, when Mr. F. Darley repeated the lecture he has given in Newcastle and Sheffield on "The Production of Steel Castings." Bradford is still to have another meeting, when Mr. A. A. Liardet will deliver his Presidential address. This meeting will be followed by a general discussion as to the working of the Branch. As the work of organising a Branch usually devolves on the honorary secretary, we offer him our congratulations on the excellent programme he has arranged.

Potash.

A new volume on the subject of potash, in the series of "Monographs on the Mineral Resources of the Empire," issued under the direction of the Mineral Resources Committee of the Imperial Institute, has just been published (price 6s.).

The Monograph has been prepared by Mr. Sydney J. Johnstone, B.Sc. (London), A.I.C., of the scientific staff of the Imperial Institute, and is a revised and enlarged edition of a former publication. It contains 122 pages, and is divided into 11 chapters.

Almost the whole of the world's output of potash is used for fertilising purposes in agriculture, and the demand for it is continually increasing, largely due to the amount of intensive farming that is now carried on. A small proportion of the potash produced is employed in the making of glass, soap, matches and gunpowder; for scouring of wool; in pharmacy, photography, electro-plating and various metallurgical industries.

The first five chapters of the Monograph describe the various sources of soluble potassium salts in the world, including the immense deposits in Germany and France, as well as, amongst others, those in the United States, Abyssinia, India, Chile, Peru, Tunis, and South Africa. The remaining chapters deal with other sources of potash, including sea water, insoluble minerals, such as alunite and the felspars, flue dust from cement and blast furnace plants, and vegetables and animal substances.

Analyses and statistics are given in important cases, and at the end of the volume there is a list of recent publications.

Trade Talk.

AN "Inventors' Union" has been formed at Birmingham.

THE PHŒNIX ELECTRICAL COMPANY, LIMITED, have removed from 32, Broomielaw, to 17, Oswald Street, Glasgow.

MR. H. F. BARTON, metal trades valuer, formerly of 31, Well Road, has removed to 133, Tonbridge Road, Maidstone.

AN outbreak of fire occurred on Saturday last at the Newport Ironworks, when damage was caused to the extent of £1,000.

THE Railway Rates Tribunal and the Rates Advisory Committee have removed to 2, Clement's Inn, Strand, London.

"THE MARINE ENGINEER IN THE MAKING" was the title of a paper read recently before the Liverpool Engineering Society by Mr. Peter Youngson.

MR. G. W. MOTTRAM, contractors' merchant, formerly of 161, New Bond Street, W.1, has removed to 1, Montague Street, Russell Square, London, W.C.1.

THE BRIGHTSIDE FOUNDRY & ENGINEERING COMPANY, LIMITED, have removed their London office, from 28, Victoria Street, to Chicheley Street, Belvedere Road, S.E.1.

EDGAR G. REES, LIMITED, have purchased with other obsolete war vessels, H.M.S. "Chester," "Swift," "Linnet," "Goshawk," and "Lizard," which they intend breaking up at Llanelly.

THOMAS W. WARD, LIMITED, have decided to close several of their shipbreaking and steel scrap depôts in various parts of the country in order to bring stocks of materials to the normal state.

THE directors of the Vulcan Foundry Company have decided this year to revert to previous practice, namely, not to pay an interim dividend in cash when a bonus issue in shares is made.

THE discovery of iron ore on the shores of Lake Athabasca, in Northern Alberta, has recently been announced by the Canadian Press, the deposits comprising many million tons. The ore is stated to carry a high percentage of hematite iron.

THE general meeting of the North-Eastern section of the Junior Institution of Engineers was held on March 10 at the Armstrong College. Mr. A. H. Fitt presided. Mr. Beard gave an address on "Some Impressions of America," with special reference to engineering practice.

A LECTURE on the present position and future prospects of industrial electrical heating was given at the University of Sheffield on March 13 by Mr. J. G. Pearce, of the Metropolitan-Vickers Electrical Company, Limited, to the Sheffield Gas Consumers' Association. Mr. D. Flather presided.

ALFRED HERBERT, LIMITED, machine tool makers, have been appointed sole agents in India, Burma and Ceylon for Plenty & Son, Limited, for the sale of their semi-Diesel marine and stationary oil engines, and will handle this agency through their associate company, Alfred Herbert (India), Limited.

THE contract for the supply and instalment of pumping machinery at Atf in Lower Egypt has been given to the Associated British Manufacturers (Egypt), Limited, at a sum of slightly over £170.000. The contract was keenly competed for by Swiss, German, French, Dutch and other manufacturers.

IT IS OFFICIALLY ANNOUNCED from Stockholm that a provisional trade agreement between Russia and Sweden has been signed by the Minister for Trade, M. Svensson, and the head of the Russian Trade Delegation, M. Kershentsev. The agreement will not come into force until it has been approved by the Riksdag.

AS PART of the series of protest meetings against the present high level of taxation which is being organised by the Federation of British Industries, in conjunction with local chambers of commerce, the following meetings have been arranged:—Luton, March 27; and Birmingham, March 30.

IRON ORE MINERS' wages in West Cumberland are to be further reduced. As the result of the ascertainment March wages will be as follows:—Underground miners' working bargains, 10s. 2d.; miners' minimum, 7s 6d.; underground labourers, 5s. 5½d.; winding enginemen, 8s. 10½d.; craftsmen, i.e., joiners, blacksmiths, etc, 9s. 2½d.

THE Railway Rates Tribunal has given public notice that it will consider the packing regulations contained in the railway companies' proposed new classification of goods by merchandise trains, published by the Railway Clearing House in December, 1920, price 3s. 6d. Any person or body desiring to object to the proposed regulations must lodge four copies of his or their detailed objections not later than April 15, 1922, with the Secretary of the Tribunal, or through the Secretary of the Traders' Co-ordinating Committee, Mr. R. L. Drage, Federation of British Industries, 39, St. James's Street, London, S.W.1.

THE annual dinner of the Institution of Mining and Metallurgy will be held on Wednesday, April 5, 1922, at 7.15 for 7.45 p.m., in the "Edward VII." Room of the Hotel Victoria, Northumberland Avenue, London, W.C.2. Full particulars will be sent to home members in due course, and the president hopes to be supported by a large attendance.

A JOINT meeting of the Associates' and Graduates' section of the North of England Institute of Mining and Mechanical Engineers, the Graduate sections of the North-East Coast Institution of Engineers and Shipbuilders and the Institution of Electrical Engineers was held in the Mining Institute, Newcastle, on March 9, when Mr. A. Pickworth read a paper on "Corrosion." Mr. E. V. Telfer presided over a good attendance.

THE sixth meeting of the thirty-first session of the Institution of Mining and Metallurgy was held at the rooms of the Geological Society, Burlington House, Piccadilly, W.1, on Thursday last. The following papers were submitted for discussion: "Notes on the Valuation of Ores, Concentrates and Smelter Products," by Mr. L. C. Stuckey; "Methods of Measuring Horizontal Angles Involving Steep or Precipitous Sighting," by Mr. L. H. Cooke.

THE total number of vessels of all kinds launched from the River Tyne during February, 1922, numbered six, of an estimated net registered tonnage of 23,890, as compared with eight vessels, of a net register tonnage of 15,345 launched during the corresponding period of last year, while the number of vessels launched during the two months ended February last numbered six, of an estimated net register tonnage of 23,890, as compared with 19 vessels, of an estimated net register tonnage of 43,399 for the corresponding period of the year 1921.

OWING to the formation by Sheffield Steel Products, Limited, of a subsidiary company, Sheffield Steel Products (Stores), Limited, the prospectus of which was recently issued, for the purpose of supplying goods direct to the consumer by means of the multiple shop system, the National Hardware Association has invited the parent firm to resign its membership of the Association. It is stated by the Association that the course taken by Sheffield Steel Products (Stores), Limited, is detrimental to the interests of the trade, and affords no corresponding advantage to the public.

LICENCES have been granted under the Non-Ferrous Metal Industry Act, 1918, to the undermentioned concerns:—Greeff & Company, Limited, R. W., Thames House, Queen Street Place, London, E.C.4; Helical Bar & Engineering Company, Limited, 72, Victoria Street, London, S.W.1; Holden, Limited, Chris., Weir Street, Blackburn; Kay Brothers (Shippers), Limited, 1, Brazil Street, Manchester; Langworthy, Ernest Frank (trading as Langworthy & Company), 25, Mountfield Road, Stamford Hill, London, N.15; Oidas Metals Company, Limited, 46, Brettenham Road, Edmonton, London, N.18; Pallister, Luck & Company, Limited, 37, 38, Hatton Garden, London, E.C.1; Palmer, Marchant & Company, 7, East India Avenue, Leadenhall Street, London, E.C.

PRIOR to the war British steel-makers obtained their magnesite and chrome bricks for lining furnaces from Austria, and these were of very high quality. When the foreign supply ceased, says the *Sheffield Daily Telegraph*, British makers came to the rescue and did their best in difficult circumstances. It is satisfactory to learn that these important products can now be obtained from home sources. The General Refractories Company, Limited, of Sheffield, who have devoted a great amount of study and experiment to the production of a brick which equals the Austrian article, have not only succeeded in their task, but their material has additional valuable qualities, and is, in fact, more refractory. It is also quite as cheap as, if not lower in price than, the imported brick. These goods are made entirely from British materials.

THE first meeting of the creditors of H. Wilkins, iron and steel merchant, who carried on business at Foster's Buildings, High Street, Sheffield, was held last week, when Mr. T. C. Parkin, junr., Bank Street, Sheffield, was appointed trustee. The debtor became aware of his insolvency about the end of 1921. His statement of affairs shows a deficiency of £4,450.

THE NAMES of the undermentioned companies have been struck off the Register of Joint Stock Companies, and such companies are dissolved: Dee Smelter, Limited; Highmeadow Iron Company, Limited; Holzer Steel Process Syndicate (United Kingdom), Limited; Kable Electrical Company, Limited; Kirkland Steel Foundry, Limited; Larran Engineering, Limited; Metal Deposition, Limited; Naval and Patent Light Steel Construction, Limited; Phœnix Iron Works, Limited; South London Engineering Company, Limited; Wallace Griffin Electrical Company, Limited; Weardale Barytes and Mining Company, Limited.

Waste in Foundries.

According to "The Iron Age," Mr. C. E. Knoeppel, in addressing the February 25 meeting of the Newark Foundrymen's Association, at the Downtown Club, Newark, N.J., on the subject of "Some Foundry Overhead Problems under Present Conditions," stated if all foundries and all manufacturers in the United States were operating at a 20 per cent. waste and this 20 per cent. of waste were also true of producers the world over, there would be no great necessity for considering waste as a great economic factor. But the relative performances of plants, industries and nations show something different in waste.

Business in the States does not know the facts of industry, past trends and future possibilities. Savings are possible in manufacture, and Mr. Knoeppel related the example of a manufacturer of pumps in the West, who, after performing a surgical operation on his pump, discovered that by thinning one metal part he saved $80,000 a year in production costs. Mr. Knoeppel's speech was based upon twelve business axioms that he points out are essential to any line of industry. These are:

1. Greatest volume of business goes to that concern whose prices reflect the normal operating conditions.
2. Those who purchase goods should pay most for that which costs most to produce.
3. Productivity (relative amount produced) is, in the last analysis, the gauge of real economy in manufacturing.
4. The real investment in a plant, in goods produced, is the hours and minutes spent on them by machines and men (from president to office boy).
5. The best insurance against loss in producing goods is advance knowledge of likely happenings.
6. That concern is best protected against uncertainties in commercial competition which is most closely in touch with all current conditions.
7. The only protection against unintelligent competition in industry is to insure that all factors are considered in setting prices.
8. No division of a business should be served at the expense or to the exclusion of other important divisions.
9. Averages should be ignored, as they mean that some items are less and others more.
10. Profits should be divided so that operating efficiency may be considered separately from sales and buying efficiency.
11. The concern which is best posted as to cost of idleness of men and machines and cost of rejections is in the best position to reduce industrial wastes.
12. Consumers and not producers are those benefited by uneconomic methods of costing and pricing.

The British Cast Iron Research Association.

The Director of Research, in his monthly report, states that during the month of February a further number of problems of varied character have been submitted for investigation and research. Most of these are of general interest and importance; it is again noticeable that the troubles incidental to shrinkage and uneven contraction are widespread in both the grey iron and malleable branches of the foundry industry. Help has been desired in the manufacture of ingot moulds, annealing pots, and of castings subject to vibration and coincident fluctuations of heat.

Members have received assistance in the following problems:—The design of cupola linings and ladles; the influence of deoxidisers in metal for light castings subject to repeated heatings; the overcoming of erosion defects in centrifugal pump casings and impellers; suitable mixtures for bearings to carry hot running shafts; the function of moisture in cupola coke; mixtures and treatment suitable for malleable castings to carry superheated steam of high pressure.

In addition to the above "every-day" type of inquiries, work has continued in the direction of accumulating further data necessary for the carrying out of the fundamental research problems in hand. In this connection the Director has been helped by the receipt of actual examples of defective castings, designs, and particulars of manufacture from a number of the members.

Company News.

Leslie & Hall, Limited.—Capital £5,000 in £1 shares. Dealers in metals. Directors: J. A. Leslie and W. F. Leslie.

Pimbley & Robinson, Limited.—Capital £25,000 in £1 shares. Metal workers. Registered office: Fleet Square, Lancaster.

Coltness Iron Company, Limited.—Half-yearly dividends on first and second preference shares paid; interim dividend on ordinary passed.

H. H. Timberlake, Limited.—Capital £30,000. General engineers, etc. Directors: H. H., Mrs. F., and H. H. F. N. Timberlake. Registered office: 28, King Street, Wigan.

Marco, Limited.—Capital £2,000 in £1 shares. Ironfounders Directors: A Robertson and F. G. Mitchell. Registered office: Rowin Works, High Road, Leytonstone, E.11.

Thos. W. Ward, Limited.—Interim dividend on ordinary for half-year ended December passed. Quarterly dividends, 5 per cent. per annum on first and second preference and employés' shares.

John C. Parkes & Sons, Limited.—Net profit, £5,417; brought forward, £3,646; available, £9,063; dividend, 4 per cent., making 8 per cent., less tax, for year; reserve, £1,000; carried forward, £3,216.

Howlett Brothers, Limited.—Capital £1,000 in £1 shares. General engineers. Directors: W. Hands, A. Howlett, H. Howlett, and F. Dobson. Registered office: 36, Dashwood Avenue, High Wycombe.

Graziani & Company, Limited. — Capital £1,000. General engineers, etc. Directors: A. G. Graziani (managing and permanent director), F. T. Fisher, and C. T. Graziani. Registered office: 115, Victoria Street, S.W.1.

Sir Wm. Arrol & Company, Limited.—Profit, including £10,623 brought in, £90,235; preference dividend for year, £19,565; depreciation, £20,000; reserve, £10,000; ordinary dividend, 10 per cent., free of tax; carried forward, £11,100.

Fallings Foundry Company, Limited.—Capital £2,500 in £1 shares. Directors: S. Holdsworth, H. J. Higginbottom, H. Higginbottom, W. Higginbottom, and W. Cooling. Secretary: S. Holdsworth. Registered office: Fallings Foundry, Doncaster Road, Wakefield.

Monk Bridge Iron & Steel Company, Limited.—Profit for 1920, £7,083; brought forward, £58,558; depreciation, £7,044; dividend on cumulative 6 per cent. preference shares for half-year ending June 30, 1920, £7,500; ditto, last half-year, £7,500; carry forward, £43,597.

Personal.

MR. A. H. LAYBOURNE, of the Isca Foundry Company, Limited, has been made a Justice of the Peace for Monmouthshire.

THE LATE Mr. F. W. Timmins, for many years secretary of E. Timmins & Sons, Limited, ironfounders, left £2,830.

MR. I. HEMMINGS, a director of the Sheffield Steel Products, Limited, has been elected on the directorate of Halley's Industrial Motors, Limited.

THE LATE Mr. E. Hopkinson, vice-chairman of Mather & Platt, Limited, and of the Chloride Electrical Storage Company, Limited, left £141,675.

THE LATE Mr. C. Lock, chairman of the Argentine Iron & Steel Company, Limited, left gross estate of the value of £143,395, with net personalty of £143,124.

MR. E. T. WRIGHT, of Messrs. Westwood & Wright, of Brierley Hill and Dudley, who died on December 18 last, left estate of the gross value of £82,387, with net personalty £36,388.

MAJOR T. C. FITZ HUGH, for some years representative in China of the British Engineers' Association, has been appointed resident commissioner in China of the Sino-British Trade Association.

THE late Mr. J. W. Haydock, of Haydock, Molineaux & Company, Limited, iron and steel merchants, Sheffield, left estate of the gross value of £4,431, with net personalty £1,196.

MR. W. SIMONS, formerly managing director of the Shelton Iron, Steel and Coal Company, Limited, is taking a holiday in Italy before entering upon his new position with Guest, Keen & Nettlefolds, Limited.

SIR HUGH REID, BART., managing director of the North British Locomotive Company, Limited, has been the recipient of a presentation from the officials in recognition of the honour of a baronetcy conferred upon him.

MR. W. N. TURNER has been appointed London and Birmingham representative of Centrifugal Castings, Limited, Kirkstyle Road, Kilmarnock, manufacturers of high-grade centrifugal castings of all descriptions by their patented centrifugal process. All communications to be addressed to Mr. Turner at his present address:—9, Shaa Road, Acton, London, W.3.

IRON AND STEEL MARKETS.

Pig-iron.

Although undoubtedly checked by the stoppage of the engineers, the demand for pig iron has by no means yet subsided to the extent anticipated, but the outlook is regarded as uncertain, and the tone of markets is distinctly less confident than was the case quite recently. In the West of Scotland chief interest just now is centred in the efforts being made to re-establish the Glasgow pig-iron warrant market. This was opened on Wednesday, the 15th inst., with a fair attendance of members, at which both buyers and sellers were present and offering quotations, but so far without any business resulting. In general trade the home department is not encouraging, but a better business is passing for export, overseas shipments from the Port of Glasgow amounting last week to 700 tons, as compared with 215 tons for the corresponding period last year. Conditions in the Cleveland iron market, though adversely affected by the prevailing labour troubles, are not altogether unfavourable, a fair number of inquiries coming forward, and the whole of the furnace outputs going promptly into consumption. Indeed so well sold are the makers that it is difficult to buy iron for immediate delivery, and even mottled and white, which have been freely offered, are now not nearly so plentiful, some of the makers having raised their price from 75s. to 80s. in consequence. Shipments from Tees-side this month are on a heavier scale, and there are grounds for belief that the foreign demand is likely to increase. Costs of production on the Continent are rising, and there is a growing tendency to seek British supplies. Consequently all prices are firmly held, but no advance has been made and business is still being done at the old official figures, viz., 95s. for No. 1 and silicious: 90s. for No. 3 Cleveland G.M.B.; 87s. 6d. for No. 4 foundry; and 82s. 6d. for No. 4 forge; either for home consumption or export.

In the East Coast hematite market the maintenance of a quotation of £5 per ton for mixed numbers has restricted buying. As a matter of fact, West Coast hematite—usually 10s. a ton dearer—can now be bought at 98s. 6d. per ton, and buyers are consequently not so keen. Still, makers with good order books are not pressing sales, although possibly they might shade 100s. for forward business. Another furnace is going into blast at Seaton Carew this week, which will bring the number of hematite furnaces up to 15 in operation on the North-East Coast. In West Cumberland and North Lancashire there are twelve furnaces in blast on hematite.

Finished Iron.

Outlining the present position in the manufacturing branches of the iron trade, there is little of an encouraging nature to report, very few transactions beyond those incidental to current consumption being recorded, while the few plants in operation appear to be working on hand-to-mouth lines. Many orders also that might have come into the market recently are held back in view of the threatening aspect of renewed labour troubles, while any inquiries placed in the market are the subject of strenuous competition amongst home manufacturers anxious to keep mills running and to retain their old connections. There is still a moderate demand for marked bars, but even that has been checked by the enforced stagnation of the engineering branches, but crown or merchant qualities are in diminished request. Keen home competition is experienced in lower-grade finished material, and prices are subject to "cut" quotations, as low as £10 10s. being on offer for these particular brands. In the West of Scotland makers of bar-iron report difficulty in obtaining orders to keep mills running, and prospects for the near future are regarded as far from encouraging. There is, however, a fair demand for export bar-iron, for which lower prices are quoted by makers. The Board of Trade returns issued last week give a poor showing of the volume of foundry work exported during the past month, cast-iron pipes, etc., only totalling 5,585 tons for the current year, as compared with 8,190 tons for the corresponding period of 1922, and cast-iron manufactures 1,004 and 1,781 tons respectively.

Steel.

So far, it cannot be said that the steel industry has been greatly affected by current labour difficulties, the lock-out at Sheffield only having partial application in the numerous departments of local trade, while in some branches a distinctly hopeful feeling is in evidence. In the last-named connection revived confidence is explained by a slightly increased volume of orders coming forward for railway material, business for springs, tyres and axles having recently been placed, though not by any means equal to pre-war quantities. The Far East also is taking an appreciable quantity of spring steel, and foreign business is, on the whole, better, due no doubt to the fact that German prices are not now such as to appeal, and to the inability of that country to guarantee early delivery. Australia, South America and India are, in particular, buying more freely. There is only a small demand for high-speed steel. On the Tees-side the markets for steel are apathetic, but there are, however, hopeful factors. It is certainly the fact that German competition is ceasing. Indeed, Germany is now a buyer, for costs of production there are rushing up, and current German prices are stated to be higher than those of France and Britain.

Scrap.

With the slowing down of the iron and steel works owing to the disturbance in the engineering industry, movements in some scrap markets are again on a restricted scale, one of the few exceptions to the general rule being that of the Midlands, where the tone is firmer than has been the case for some weeks past. This result is perhaps partly due to the increased prices offered by the Welsh consumers, where quotations for heavy steel material will enable merchants to supply this quality of metal in preference to local works. The current quotation now works out at 50s. to 55s. for heavy steel scrap, with wrought-iron piling scrap at 75s.; heavy stamping scrap, 45s.; balling iron, 65s.; steel turnings, 35s; cast-iron borings, 30s.; heavy cast-iron scrap, 75s. to 80s.; and light cast-iron scrap, 60s. f.o.r.

Metals.

Copper.—The weakness recently developed in the metal markets may be attributed partly, no doubt, to home labour troubles, while the continued restriction of consumptive demand has also had an adverse effect upon buying movements. Standard copper prices are now almost entirely controlled by American exchange conditions, but fluctuations during the past week have been confined within comparatively limited range, buyers, as a rule, hesitating to increase commitments. The week's opening market disclosed an easier tendency, showing a loss of about 10s., on which basis most of the business was done. March dates were quoted £59 5s. to £59 7s. 6d.; April, £59 10s. to £59 12s. 6d.; June, £60 5s. to £60 10s. Refined sorts were a shade weaker with electrolytic, 5s. to 15s. down at £67 5s. to £67 10s. to £67 15s., with wire bars at the same levels, showing a decline of 15s. Closing prices:—Cash: Wednesday, £60 5s.; Thursday, £60 5s.; Friday, £60; Monday, £59 10s.; Tuesday, £59 2s. 6d. Three Months: Wednesday, £61 5s.: Thursday, £61 2s. 6d.; Friday, £60 17s. 6d.; Monday, £60 7s. 6d.; Tuesday, £60.

Tin.—Eastern advices report only moderate offerings by producers, and the tendency in the tin markets on this side has been somewhat weaker on the whole. Shipments of tin for the month are expected to be approximately 5,000 tons. No change in the situation in China is reported, and stocks in that country still tend to accumulate. Trade consumption has continued on a poor scale. This applies equally to the home as well as to the Continental demand. The week's opening market was easier, with a decline of 30s. in the forward position. Improved buying for three months' metal, however, developed, and with some fairly substantial buying to cover, the initial loss was recovered. March deliveries were done at £143 10s. to £143 5s.; May, £144 10s., with English ingots unchanged at £142 10s. London tin stocks are 150 tons heavier on the week at 4,732 tons, with Liverpool stocks showing an increase of 146 tons at 1,849 tons. Closing prices:—Cash: Wednesday, £143 12s. 6d.; Thursday, £143; Friday, £143 7s. 6d.; Monday, £143 10s.; Tuesday, £143 7s. 6d Three months: Wednesday, £145 12s. 6d.; Thursday, £145; Friday, £145 5s.; Monday, £145 5s.; Tuesday, £144 17s. 6d.

Spelter.—The market for this metal continues firm, a fair measure of support having been forthcoming, and the price has rallied. But a partial reaction followed, reducing the gain, the demand having slackened off a bit. Producers still show a somewhat independent attitude and metal is coming forward slowly. The demand has been mainly for prompt delivery. Closing prices:—Ordinary brands: Wednesday, £26; Thursday, £26 5s.; Friday, £26; Monday, £25 15s.; Tuesday, £25 15s.

Lead.—In this market there has been some fairly good buying, chiefly for export, and this has synchronised with restricted supplies on account of labour troubles at some of the mines. The price advanced and this induced some bear covering and helped it to go higher still, but the full rise has not been maintained, latter days witnessing some reaction. English closing prices: Wednesday, £22 15s.; Thursday, £23 5s.; Friday, £23; Monday, £22 15s.; Tuesday, £23.